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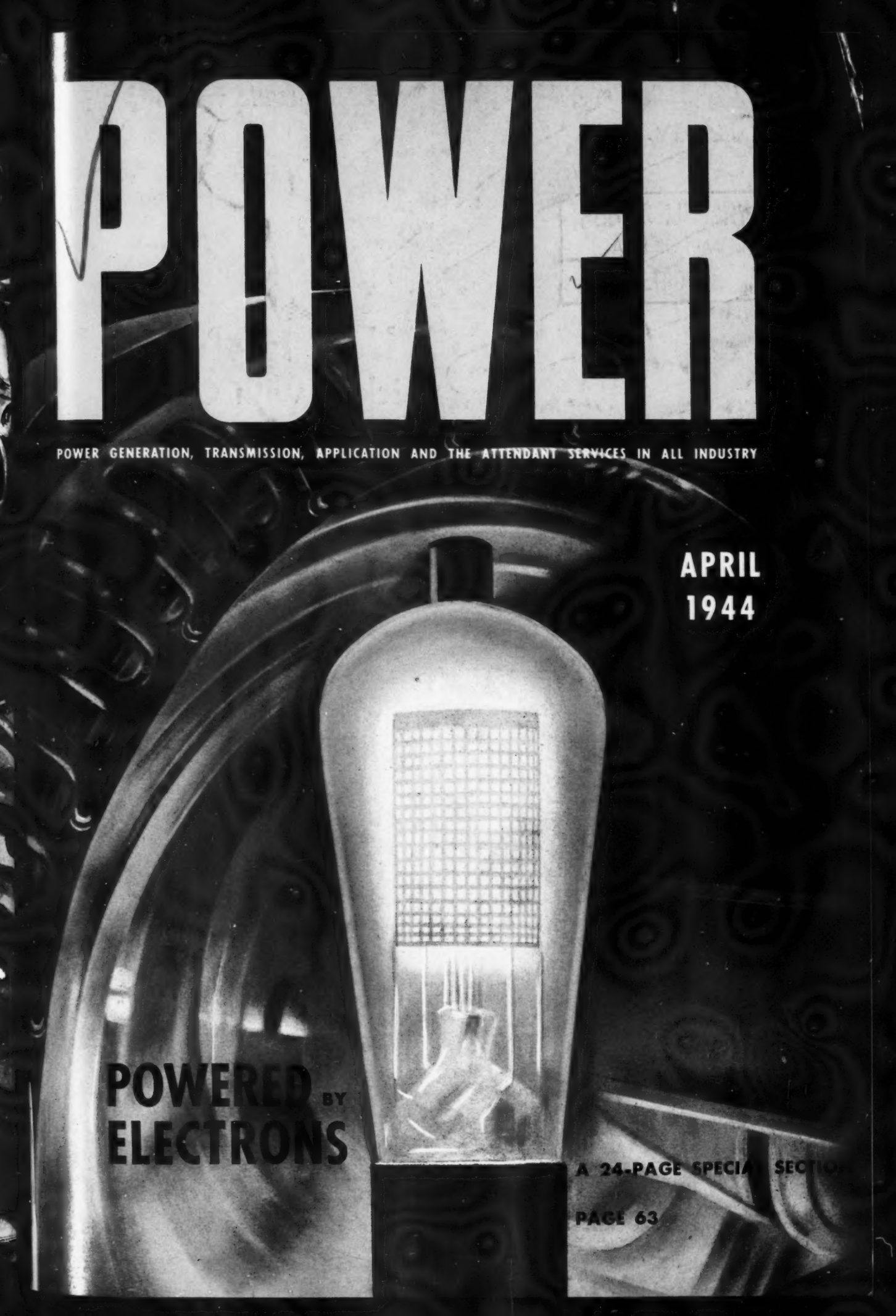

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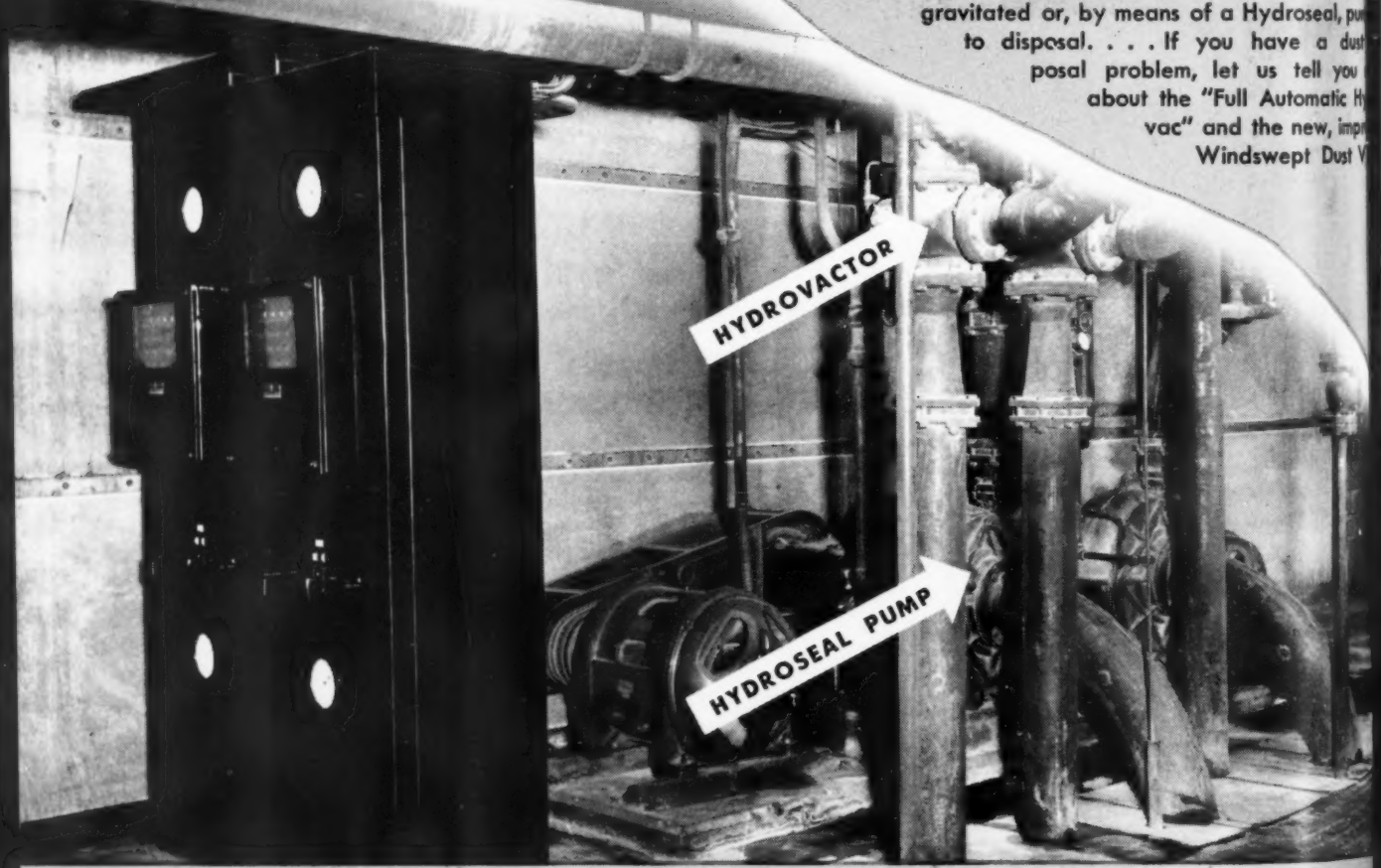
A 24-PAGE SPECIAL SECTION

PAGE 63

SEE ASH FOR ASH and DUST HANDLI

DUST HANDLING
"Licked with One Hand"

With the "Full Automatic" Hydrovac Dust Handling System, the mere throwing of a switch (a one-handed job), on the remote control operating panel, starts the removal of dust from various hoppers throughout the plant. One Windswept Dust Valve after another opens, feeds dust and closes, and when the last hopper is clean, the system automatically shuts down. Signal lights on the control panel show which hopper is being emptied of dust. . . . No labor for attendance is required. Dust cannot escape from th system, for it is air-borne through a pipeline, either to a clone collector when dry recovery is employed, or, as trated, into the vacuum-producing water streams o Hydrovactor. The mixture of water and dust is gravitated or, by means of a Hydroseal, pu to disposal. . . . If you have a dust posal problem, let us tell you about the "Full Automatic H vac" and the new, impr Windswept Dust V



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TECHNOLOGY DEPT.

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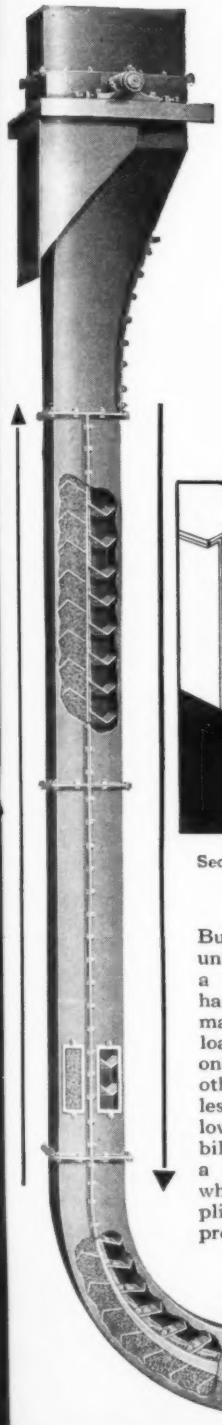
DETROIT

How a Small Steam Plant Solved a Coal Handling Problem

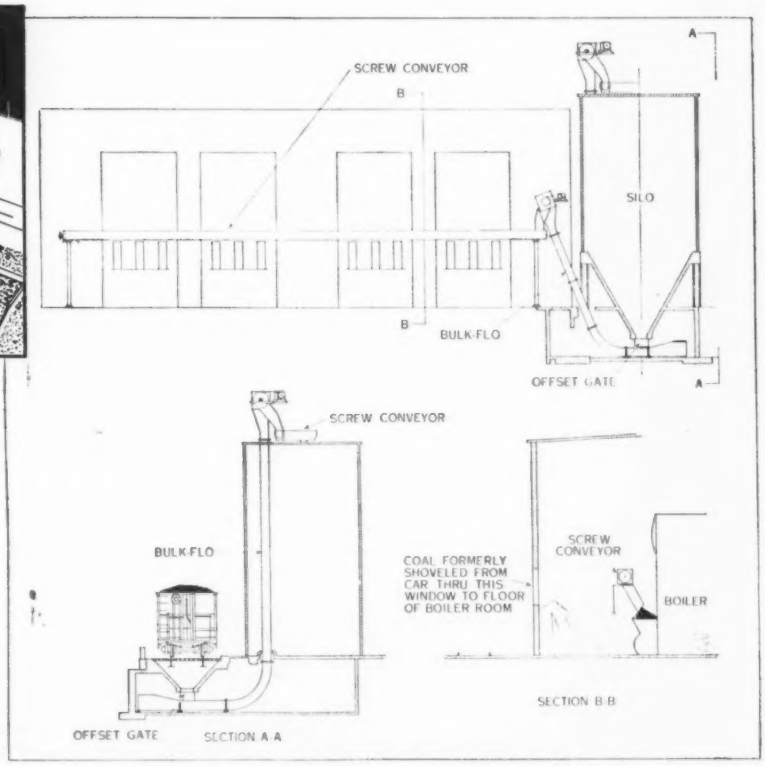


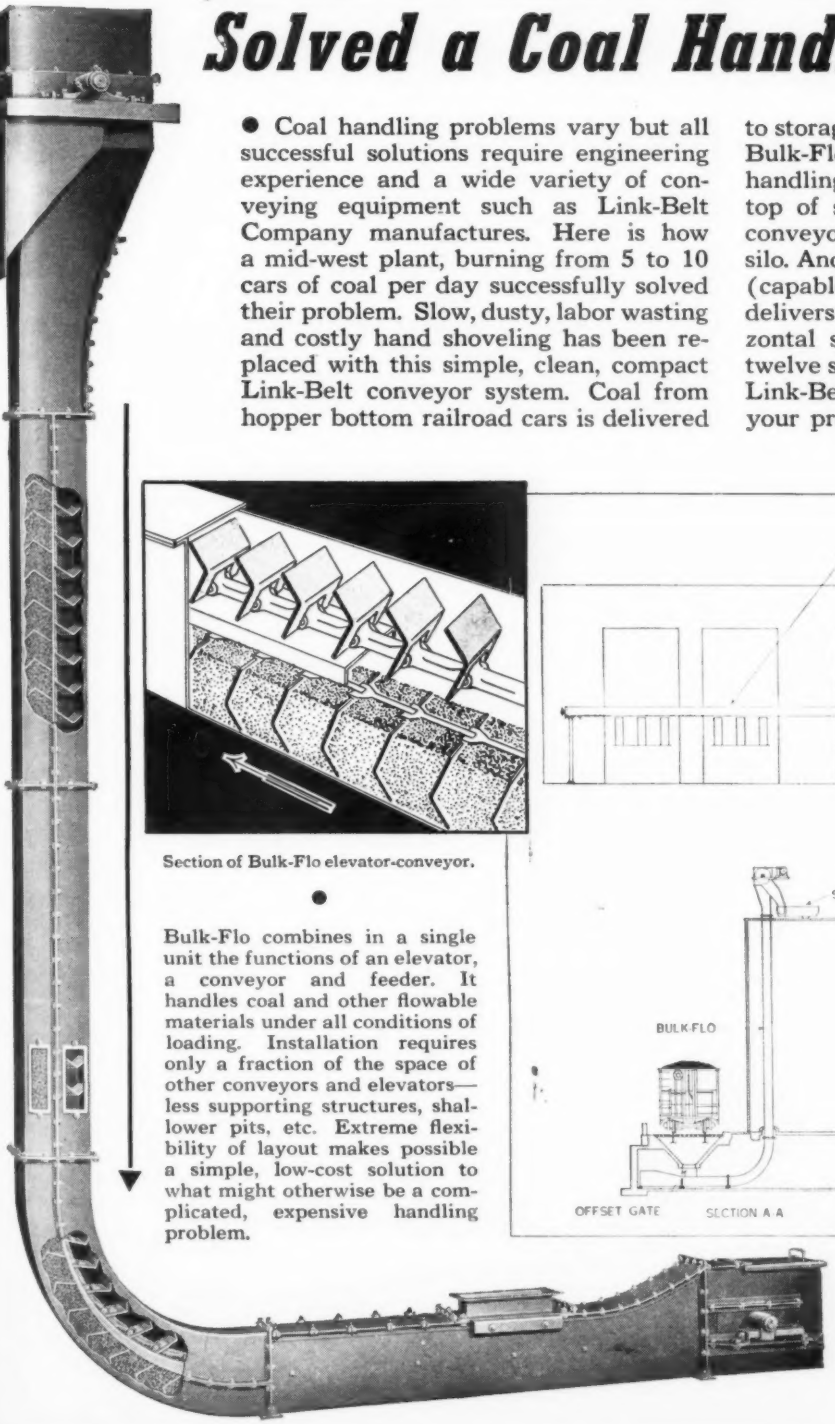
• Coal handling problems vary but all successful solutions require engineering experience and a wide variety of conveying equipment such as Link-Belt Company manufactures. Here is how a mid-west plant, burning from 5 to 10 cars of coal per day successfully solved their problem. Slow, dusty, labor wasting and costly hand shoveling has been replaced with this simple, clean, compact Link-Belt conveyor system. Coal from hopper bottom railroad cars is delivered to storage silo (200-ton capacity) with a Bulk-Flo elevator-conveyor (capable of handling 30 tons of coal per hour). On top of silo is a short horizontal screw conveyor discharging coal to center of silo. Another Bulk-Flo elevator-conveyor (capable of handling 15 tons per hour) delivers the coal from the silo to a horizontal screw conveyor which feeds all twelve stoker hoppers of the four boilers. Link-Belt is prepared to help you solve your problems. Send for Catalogs.

Section of Bulk-Flo elevator-conveyor.

•

Bulk-Flo combines in a single unit the functions of an elevator, a conveyor and feeder. It handles coal and other flowable materials under all conditions of loading. Installation requires only a fraction of the space of other conveyors and elevators—less supporting structures, shallower pits, etc. Extreme flexibility of layout makes possible a simple, low-cost solution to what might otherwise be a complicated, expensive handling problem.





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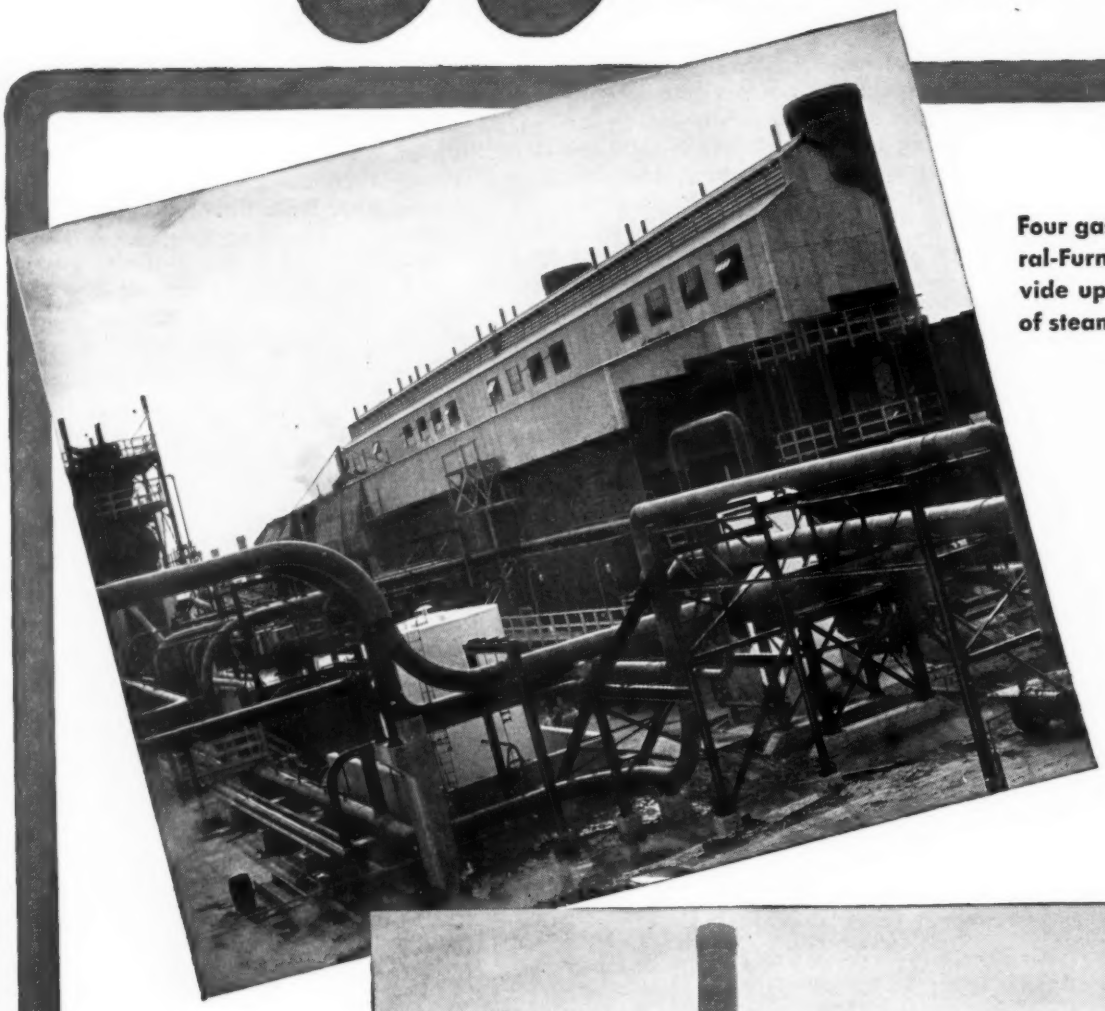
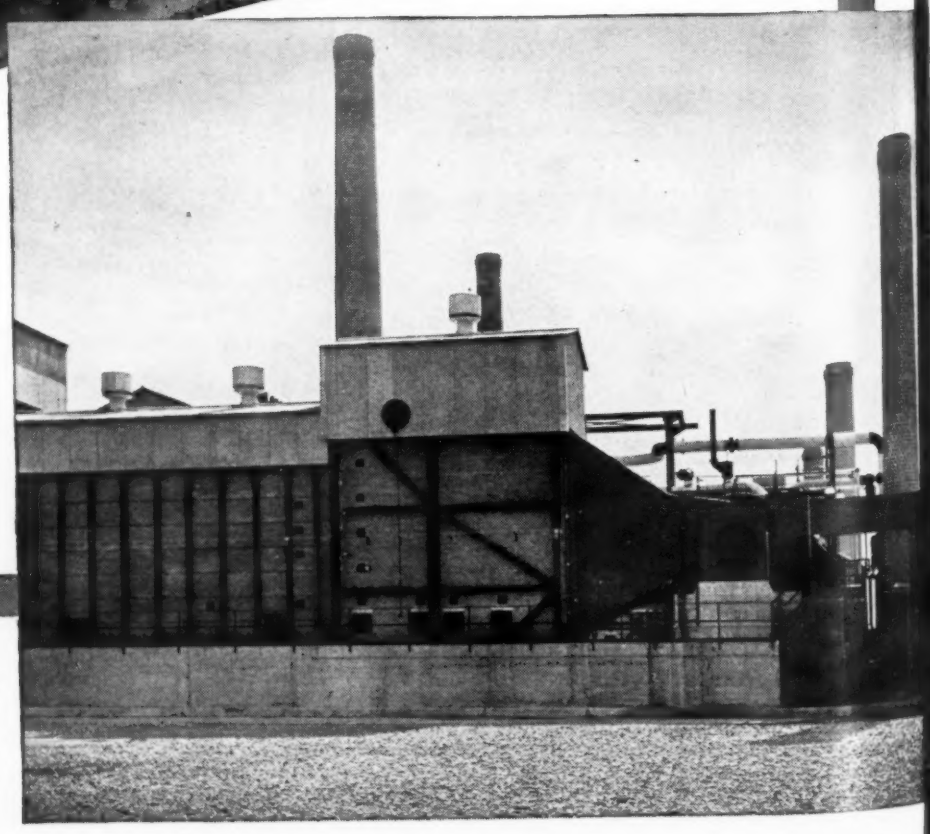


Four gas-fired B&W Inte
ral-Furnace Boilers pr
vide up to 50,000,000 l
of steam a day at 450 ps



About half the steam from the boilers is re-heated to 1250° F. in six B&W gas-fired superheaters.

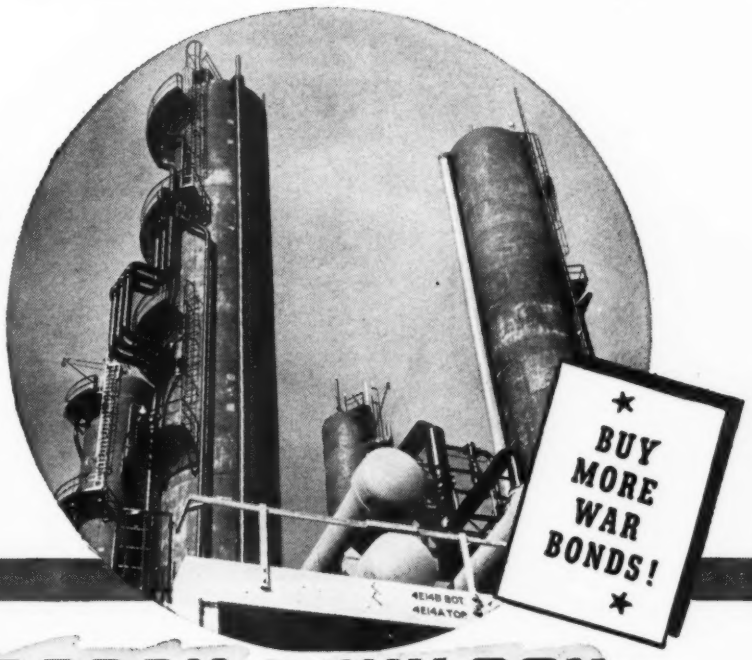
Photographs courtesy of The Lummus Company

POUNDS OF STEAM *to* BOOST BUTADIENE *Production*

The butadiene plant at Port Neches, one of the world's larger plants, is designed to produce 100,000 tons of butadiene annually—enough for one-seventh of the government's war-time program for vital synthetic rubber production. This plant provides a strange new skyline for this part of Texas, with steel fractionating towers rearing their tops as high as a 17-story building.

The 50,000,000 pounds of steam required daily for high-temperature heating processes, low-temperature boiling, and for power drives will be provided by 4 B&W Integral-Furnace boilers of central-station size. About half the steam from the boilers is re-heated in specially designed separately-fired superheaters of B&W manufacture, in which the temperature is raised to the high degree necessary for dehydrogenation of butylene, the most difficult step in the process.

To the originators of this important project and to The Lummus Company, designers and builders of the plant, go the sincere congratulations of this Company for the spirit in which it was undertaken, organized, and carried out. We are proud that we were called upon to contribute to the project from our experience with high-temperature steam problems and fabrication of welded pressure vessels.



Sky-scraping fractionating towers were fabricated on the site from steel plate under B&W supervision in a specially constructed shop, the design and erection of which were supervised by B&W engineers.

G-269 T

BABCOCK & WILCOX

THE BABCOCK & WILCOX COMPANY

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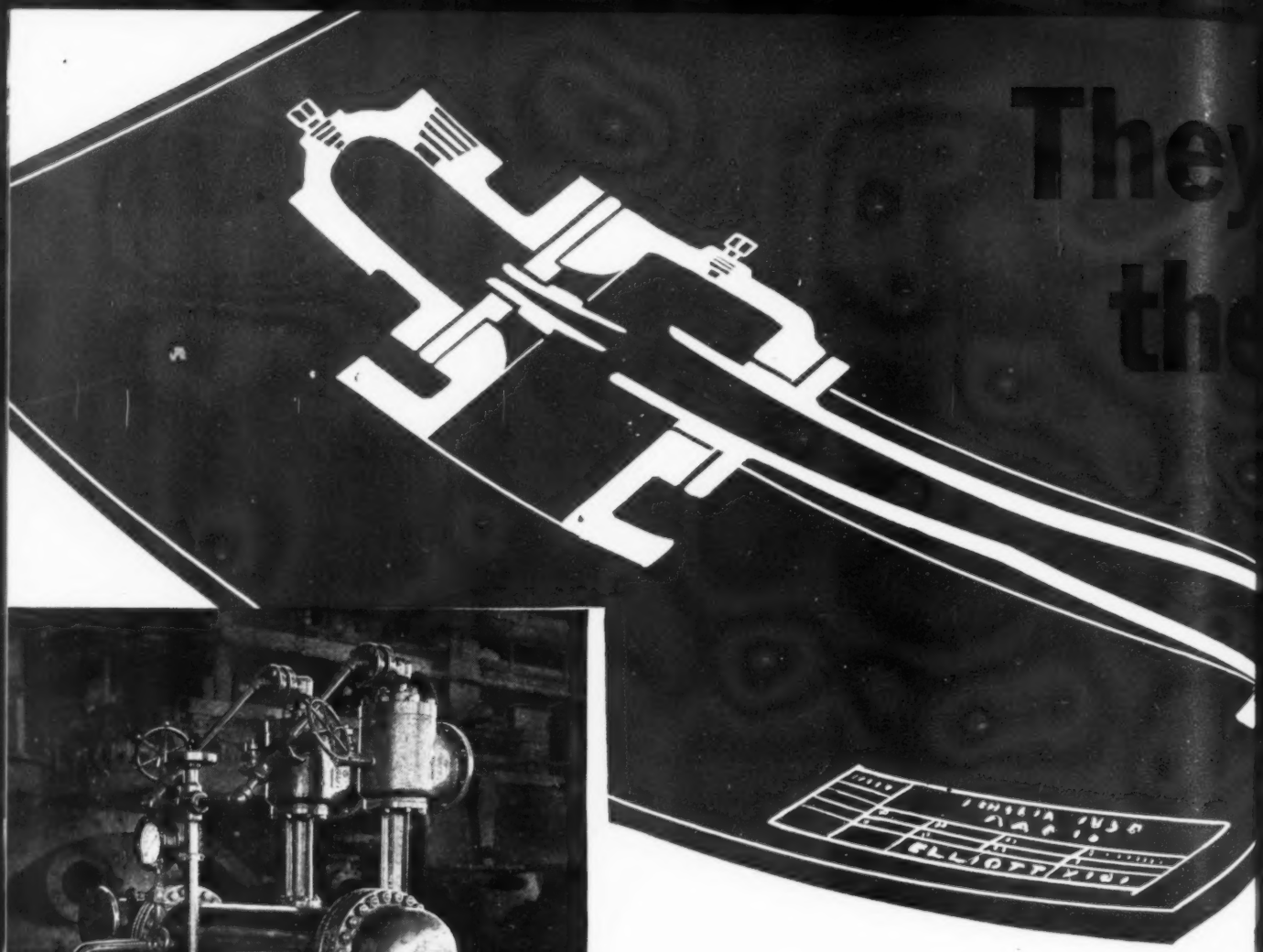
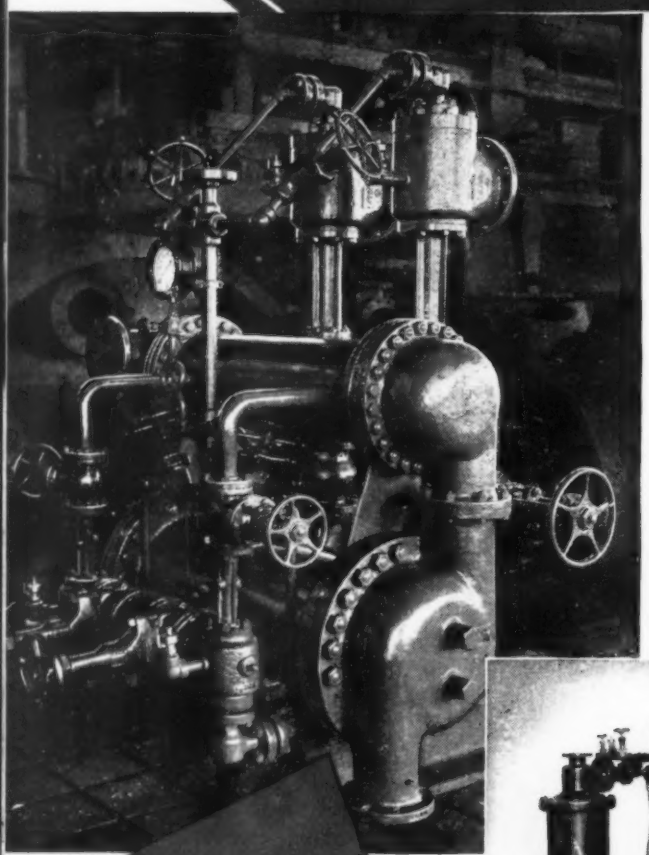
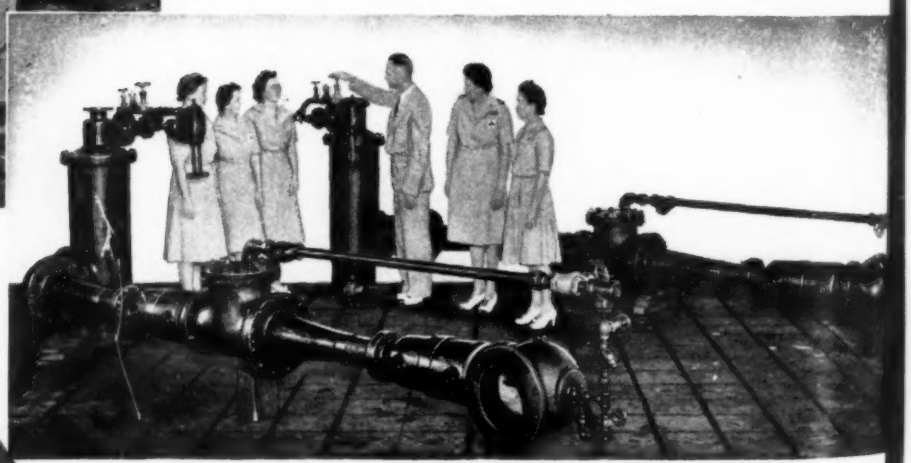




Elliott twin two-stage ejector, with surface type inter- and aftercondenser, to serve an Elliott 27,000-sq.-ft. surface condenser in a new high-pressure utility station.

An example of Elliott multi-stage ejectors maintaining extremely high vacuum on processes is the application to the drying or subliming of blood plasma. Many Elliott four-stage ejectors like this are in this service. Elliott five-stage ejectors, obtaining even higher vacuum are being used in the processing of such things as magnesium and penicillin.



ELLIOTT ENGINEERING insures fine performance in

Steam Jet Ejectors

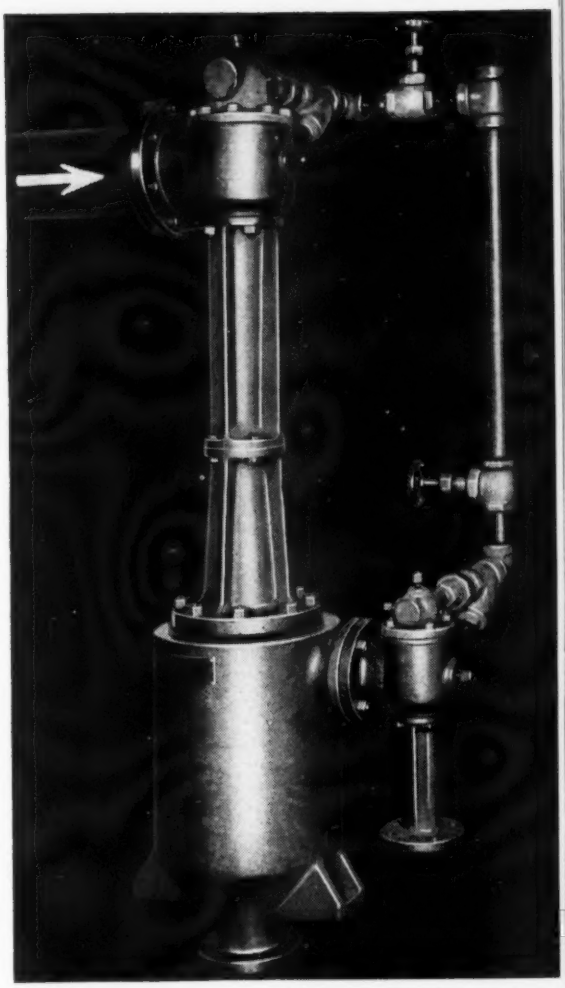
know how to get VACUUM you want

ELLIOTT ENGINEERS

have made a specialized study of the steam jet ejector over a period of 25 years, being the first to go "all-out" for the steam jet ejector as the vacuum pump for condensers. Their development of the ejector to get higher and higher vacuum, led to multi-stage ejectors for various kinds of process applications. They have made the ejector the modern vacuum pump.

While the toughest applications are in the process industries, Elliott Company can also help power plant engineers in correctly applying ejectors to serve condensers old and new. Some plants are still using reciprocating vacuum pumps, which can always be replaced to advantage by modern correctly-applied steam jet ejectors at a saving in operating and maintenance costs.

Why not profit by the background of experience of Elliott engineers. Check with them on your vacuum problem. Write for Ejector Bulletin G-7.



This type of two-stage ejector with barometric type inter-condenser is used to serve barometric type condensers in many power plants, also is widely used in process industry applications.

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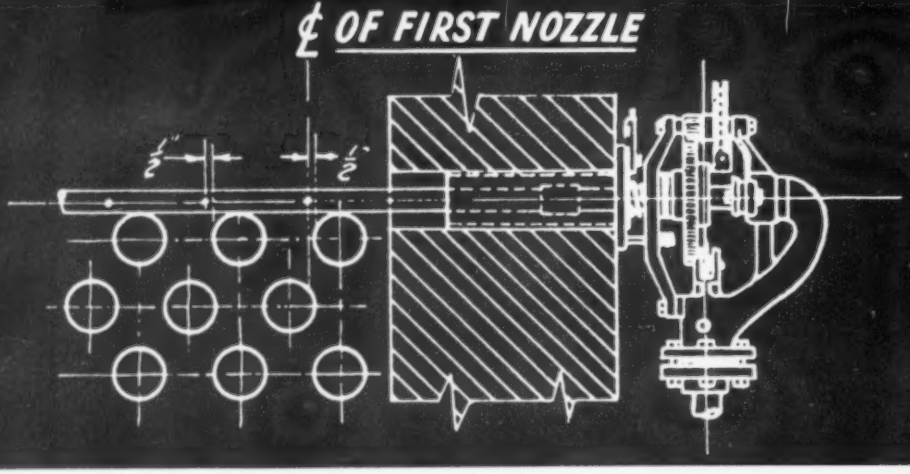
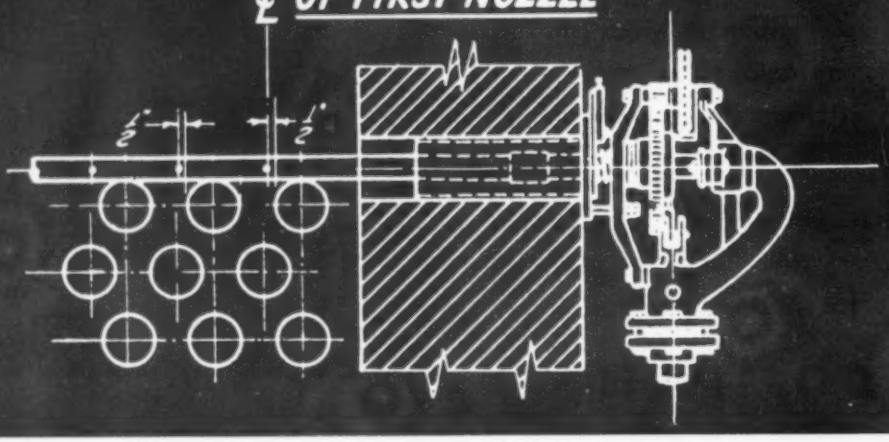
by ELLIOTT

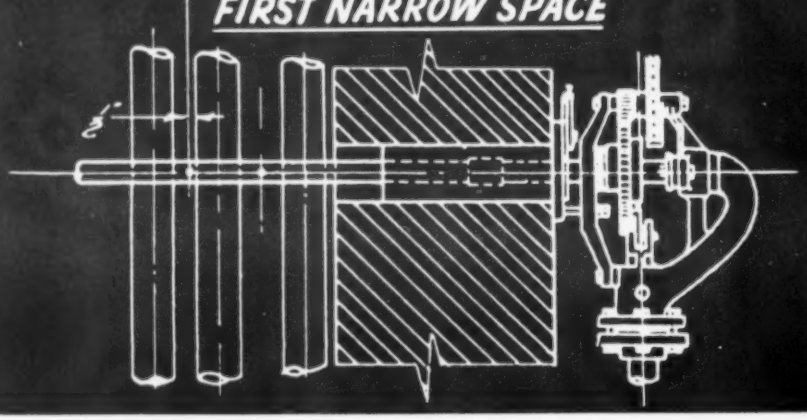
GET MORE out of the SOOT BLOWERS you have



EVENLY STAGGERED TUBES



UNEVENLY STAGGERED TUBES



UNEVENLY SPACED TUBES

CORRECT NOZZLE SETTING IS NECESSARY TO EFFICIENT BLOWING

Correct setting of nozzles is necessary to efficient boiler cleaning—removal of soot with minimum expenditure of steam.

Each time a boiler is taken out of service, all soot blower elements should be checked for correct nozzle setting. Scoring of tubes usually indicates impingement of steam jets—the nozzles are positioned too close to some of the tubes.

Correct setting is a simple matter. Elements should be adjusted so that the first nozzle is ½-inch away from the far side of the tube nearest the head. Measurements are taken, of course, from the tube row nearest the element.

If it is necessary to move the element ½-inch or less in order to properly line up the nozzles with the tubes, the head can easily be moved in or out by adjusting the nuts on the bracket stud or adjustment sleeve stud. If larger adjustment is necessary, this may be made by cutting off the swivel tube or by putting in a longer one, as the situation requires.

URGENT WAR NEEDS

DEMAND

LONGER BLOWER LIFE

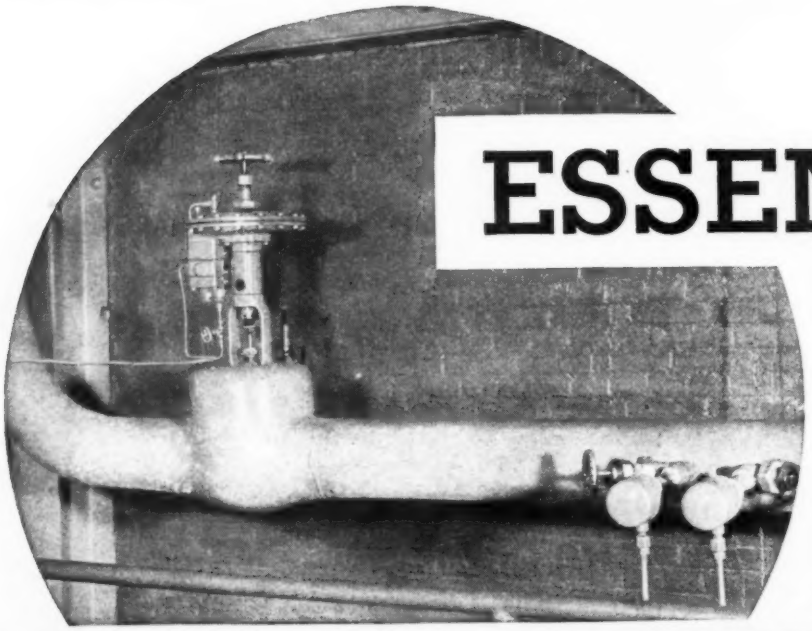
Diamond, in common with many other firms, is meeting heavy war demands. It is not always possible for us to supply new blowers or repair parts as quickly as you need them.

Careful maintenance and repair will prolong the life of the soot blowers you have—defer the time when new blowers or repair parts are needed.

This booklet has been prepared for the purpose of helping you do this. Write for a copy.

DIAMOND POWER SPECIALTY CORP.
Detroit, Michigan

DIAMOND SPECIALTY LIMITED, Windsor, Ontario



ESSENTIAL

Bailey Feed Water Control Valv

Bailey Boiler Control Panels for t
135,000 lb. per hour capacity, a
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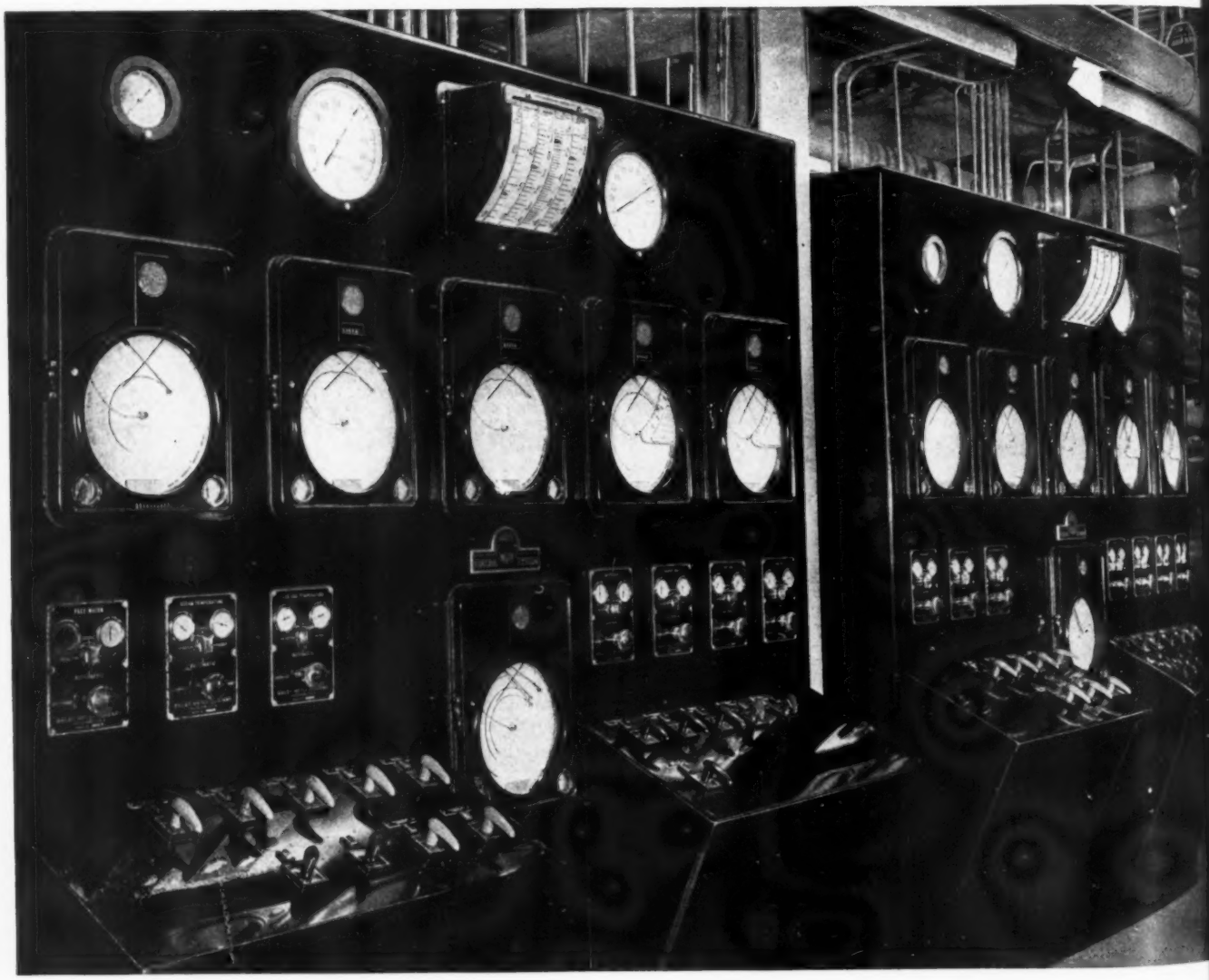

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BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHE

IN *WAR,* PROFITABLE IN *Peace*

Bailey Boiler Control Conserves Fuel, Insures Safety, Increases Turbine Efficiency, Improves Continuity of Service and Simplifies Training of Operators . . . . .

★ The same qualities of Bailey Boiler Control which make it essential in wartime power plant operation, make it profitable to use in peacetime operation.

It conserves fuel and fuel transportation facilities by automatically maintaining the correct fuel—air ratio for efficient combustion at all times.

It insures against accidents to operators and equipment by:

Accurate control of boiler water level, steam temperature and fuel—air ratio.

Interlocks to insure the proper sequence of operation.

Limiting devices to prevent operation under unstable conditions.

Alarms to warn operators of dangerous conditions such as high or low water level, flame failure, loss of air pressure, etc.

It increases turbine efficiency by supplying steam at design pressure and temperature at all times.

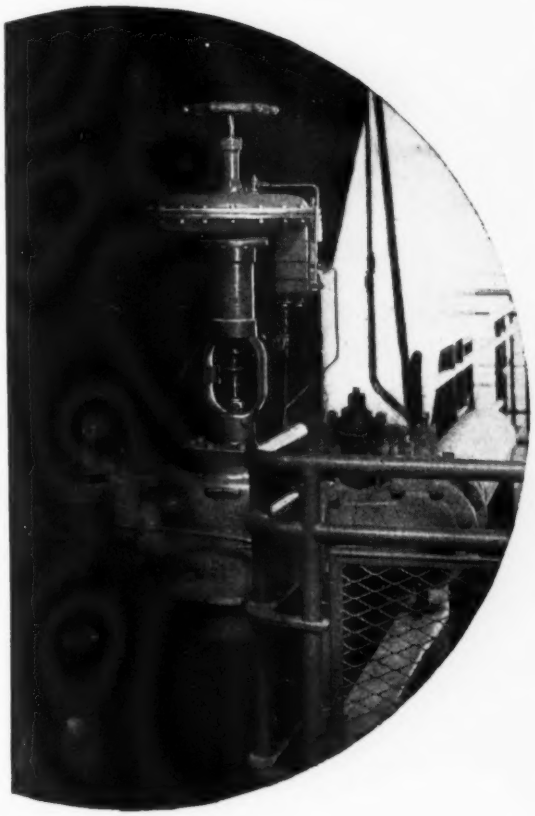
It improves the continuity of service by reducing furnace and boiler repairs.

It simplifies training of new operators and insures continuous economy during the training period.

These same qualities of Bailey Boiler Control which are now helping to win the war will help American industry to win the peace.

Suggestions for wartime boiler plant operation are given in our Bulletin No. 16 "How to Safely Stretch Steaming Capacity." Ask for your copy now.

A-90



Bailey Gas Flow Control Valve.

BAILEY METER COMPANY

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Bailey Meter Company Limited, Montreal, Canada

he Complete Combustion Control System

NTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

ALL FOUR OF THESE PHILADELPHIA E

ARE YARWAY VALVE E

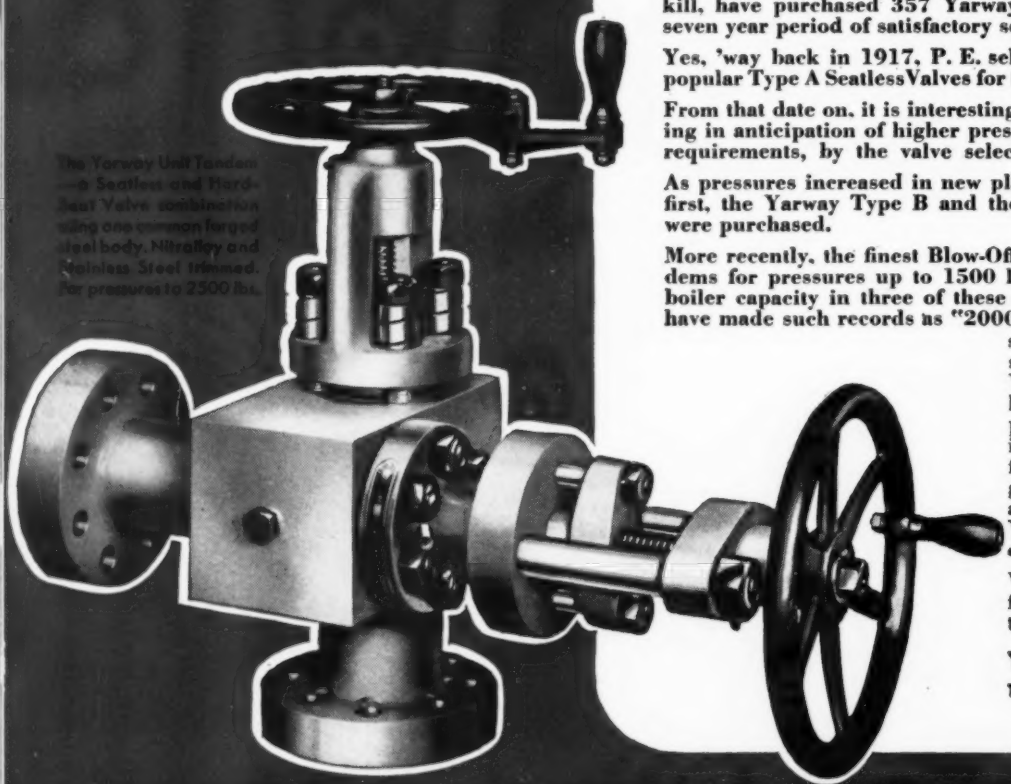
TOTALLING over 900,000 kw. these four Philadelphia Electric Company Stations—Richmond, Chester, Delaware and Schuylkill, have purchased 357 Yarway Blow-Off Valves over a twenty-seven year period of satisfactory service.

Yes, 'way back in 1917, P. E. selected their first YARWAYS—the popular Type A Seatless Valves for the then "high pressure" of 300 lb.

From that date on, it is interesting to trace Yarway's valve engineering in anticipation of higher pressures and more strenuous service requirements, by the valve selections of this outstanding utility.

As pressures increased in new plants, additions and conversions—first, the Yarway Type B and then the Type C Seatless Tandems were purchased.

More recently, the finest Blow-Off Valves of all—Yarway Unit Tandems for pressures up to 1500 lb—have been the choice for new boiler capacity in three of these plants. These are the valves that have made such records as "2000 blows at more than 1300 lb pressure without replacement of a single part or repairs of any nature." Yarway has "grown up" with many leading utilities and industrial power plants—over 12,000 of them in fact—and such records of satisfactory service in the past are your guarantee of dependable performance in the future when you select Yarway Valves for blowing down or draining and sealing service.



The Yarway Unit Tandem—a Seatless and Hard-Seat Valve combination using one common forged steel body. Nitralloy and Stainless Steel trimmed. For pressures to 2500 lbs.

Write for Catalog; Section B-431 for pressures up to 2500 lb, Section B-424 for lower pressures.

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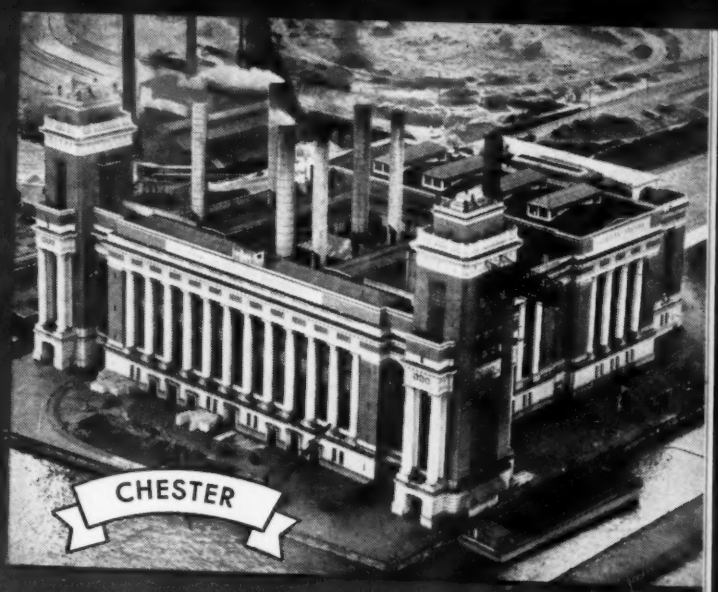

ELECTRIC STATIONS

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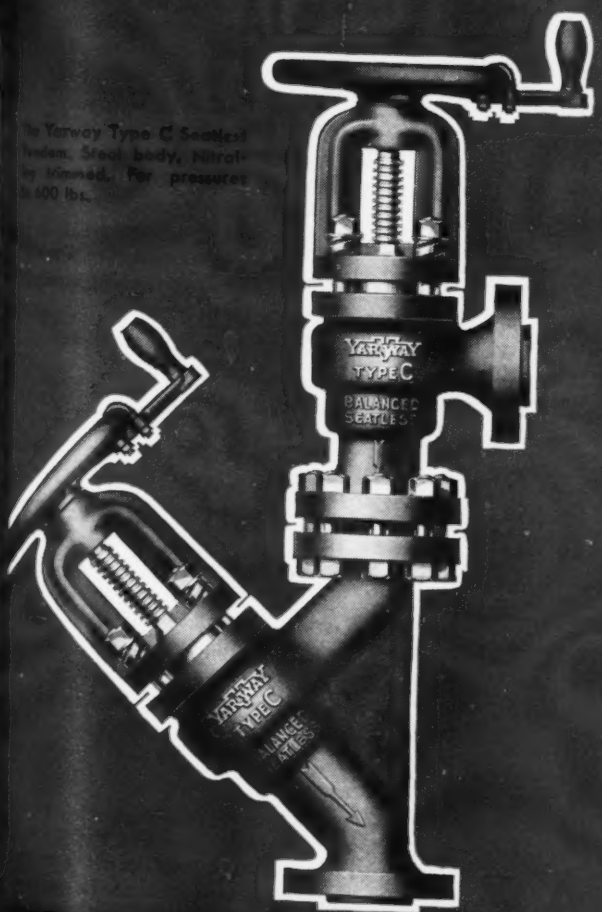


BLOW-OFF VALVES

Scovill Tube News

Vol. 2 SCOVILL MANUFACTURING COMPANY, Waterbury 91, Conn. No. 3

Condenser Tube Installation Methods and Their Influence on Tube Life

Scovill engineers discuss the proper controls to prevent the most common troubles

The importance of proper tube installation in tubular heat exchangers has been repeatedly demonstrated both for new equipment and for retubing. Tube life and tube sheet life frequently have been shortened by the lack of proper control over the installation method. Distorted and cracked tube sheets; corroded, split, and cracked tubes — all have resulted from excessive or improper rolling or joint design.

As the importance of installation methods has become generally recognized, various controls have been developed to prevent excessive rolling — the most commonly encountered fault: —

1. Tubular "stops" are placed on the expander mandrel behind the carriage to prevent mandrel entrance beyond the desired point.
2. Limited pneumatic pressure is used for the operation of expander air motors.
3. Expanders are available fitted with cylindrical rolls, and with mandrels tapered in front and cylindrical at back. Tapered section of mandrel expands tube the desired amount, after which rolls slide over into cylindrical section of the mandrel and do no further work.

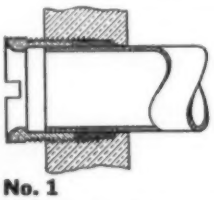
These and other methods are successfully used for *control* which is one of the primary requirements.

Scovill's tube engineers always have recognized the importance of proper installation on tube and unit life and have pioneered many of the improved tools and methods.

Since the tubular "stop" on the expander mandrel — as a means for controlling expansion — is simple, positive, applicable to all standard expanders, and calls for no specialized equipment, it has been used and widely recommended by us.

The following eight illustrations show methods of installation, and give a brief explanation of the advantages or disadvantages of each. More complete information is contained in "Scovill Condenser Tubes", a new edition of which will shortly be available.

Detail data given is authoritative for nonferrous tubes of common condenser tube sizes only (⅝" to 1¼" O.D. and 14 (.083") to 18 (.049") Ga.), but many of the details and practically all of the principles can and should be applied to other sizes and materials.

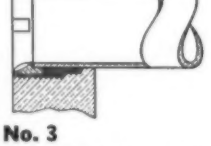


Method No. 1

Formerly the usual method of installing tubes in marine and stationary steam condensers. Inferior because of:

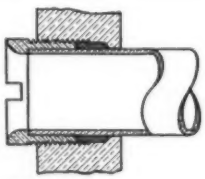
A. Protrusion into water box to create turbulence.

B. Pocket between inside shoulder of ferrule and tube end.



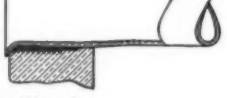
Method No. 3

This "flush-type ferrule"* can be installed as easily as the regular projecting type, but with this method, no inlet end air pocket is formed; and as there are no projections into the water box, turbulence is kept to a minimum.



Method No. 2

Where protruding inlet end ferrules must be used, install as shown with the tube end fitted snugly into ferrule shoulder. Allow for expansion at the outlet end.



Method No. 4

Recommended for renewing old tube sheets originally using ferrules. For this method a special bushing is inserted to replace the ferrule. The bushing is then reamed, radius cut, and grooved, after which the tube is expanded, flared, and beaded into position. See notes I, II, IV, V, VIII.

**Patented*

NOTES

I — Air entrained in the circulating water, or released from solution by turbulence or low pressure areas, frequently has a destructive effect on tubes. Streamlining of tube inlet ends reduces turbulence and minimizes the release of air from solution. This is of vital importance in steam condensers.

In oil refinery heat exchanger units, often operated under pressure, velocities are commonly so low, and impingement attack so uncommon, that tubes are satisfactorily installed by expanding without flaring or beading.

II — Reamed hole tolerances should not exceed plus and minus .002".

III — Locating inlet end of tube and avoidance of creep during expansion — any one of several methods may be used.

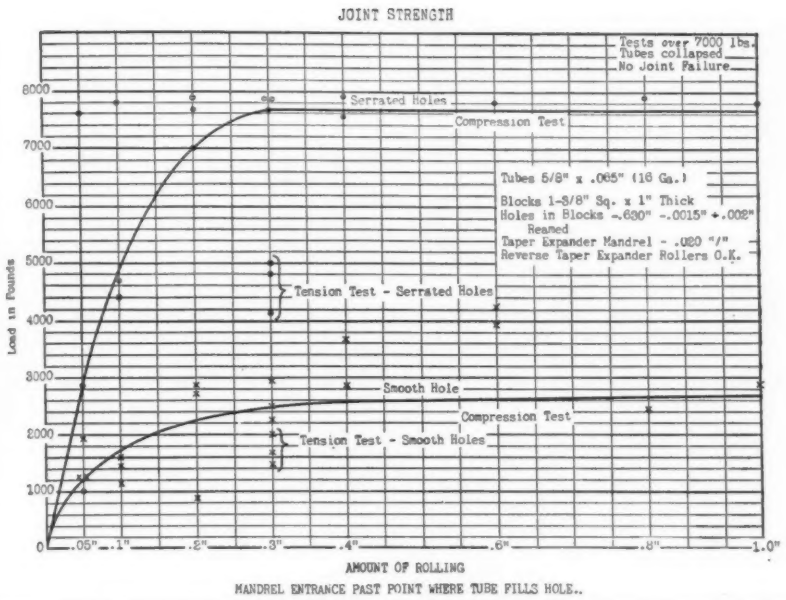
A. Scovill screw-in holding tool at outlet end, or Scovill combination tube puller and holder.

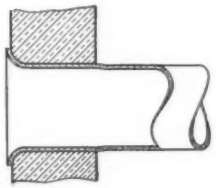
B. The outlet end, if to be expanded, may be rolled first, and the tube faced to length at the inlet end.

C. Expanders supplied by Scovill are recessed to receive the tube end and arranged to set the tube in the proper position where its location may be noted and held by a workman at the outlet end.

IV — Expanded length should extend through the tube sheet to prevent space between sheet and tube in which corrosive shell side media might collect, stagnate, and initiate active corrosion.

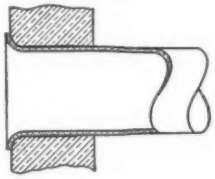
V — Expanded length should not extend beyond inner face of tube sheet, otherwise, an unsupported expanded section subject to stress corrosion or fatigue cracking will be created.





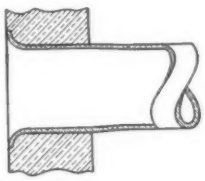
Method No. 5

Expanded to metal vs. metal joint with tube sheet. Tube sheet must be drilled, reamed, radius cut, after which the tube is expanded, flared, and beaded. This method is superior to methods No. 1 and No. 2. See notes I, II, III, IV, V.



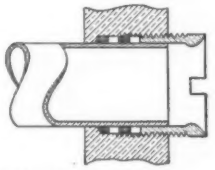
Method No. 6

In this method, the tube is expanded into a serrated hole which provides superior joint strength and permanence without excessive expansion. Tube sheet must be drilled, reamed, radius cut, grooved, after which the tube is expanded, flared, and beaded. See notes I, II, III, IV, V, VII, VIII.



Method No. 7

This is a refinement of method No. 6, but in method No. 7 the tube sheet has been recessed so that the beaded tube is flush with the tube sheet surface. This method requires that the tube sheet be drilled, reamed, radius cut, recessed, hole grooved, after which the tube is expanded, faced off to exact length if required, flared, and beaded. See notes I, II, III, IV, V, VII, VIII.



Method No. 8

This illustrates the use of Scovill's improved streamline ferrule for outlet end joints. It provides ample room for tube expansion, but the streamlined shoulder prevents the tube from dropping free of the inlet tube sheet. Although not illustrated, satisfactory outlet end joints can also be made without ferrules by the use of alternate rings of soft metal and fibre in the proper proportions.

VI — A short bevel or radius at inner face of tube sheet holes is recommended to minimize the potentially damaging effect of sharp edges against which vibration may occur and stresses concentrate.

VII — Allowance should be made for expansion and contraction of tubes due to thermal differentials in service. Various methods are used successfully.

A. Expansion joints in shell.

B. Floating heads (commonly used in small exchangers).

C. Bowed tubes — bow should be upward in order that tubes will drain when idle. This is frequently of great importance.

D. Tubes tight and fixed at inlet ends — pressure tight but free to slip at outlet ends (as with alternate rings of soft metal and fibre in proper proportions).

E. Tubes rolled at one end, then heated slightly over operating temperature and rolled at other end while hot. Tubes are then under slight tension when cold, but of proper length, and without stress while operating. The stress while idle has never, within Scovill's experience, caused trouble.

VIII — Serrated vs. smooth tube sheet holes. The advantage in joint strength obtained through the use of serrated tube sheet holes is clearly demonstrated in the chart in upper left corner.

TWO OTHER SCOVILL SERVICES —

The information in this article is illustrative of Scovill *Service in Manuals.* Other Scovill services welcomed by heat exchanger operators are *Service in Metals* — which means the facilities of our laboratories (as national needs permit) to help determine the best alloy for your conditions . . . and *Service in Men* — which means close cooperation from Scovill engineers in planning proper installation and in investigation where necessary.

For Scovill's new manual, advice on metals, or personal service of a Scovill engineer, address Scovill Manufacturing Co., 13 Mill St., Waterbury 91, Conn.

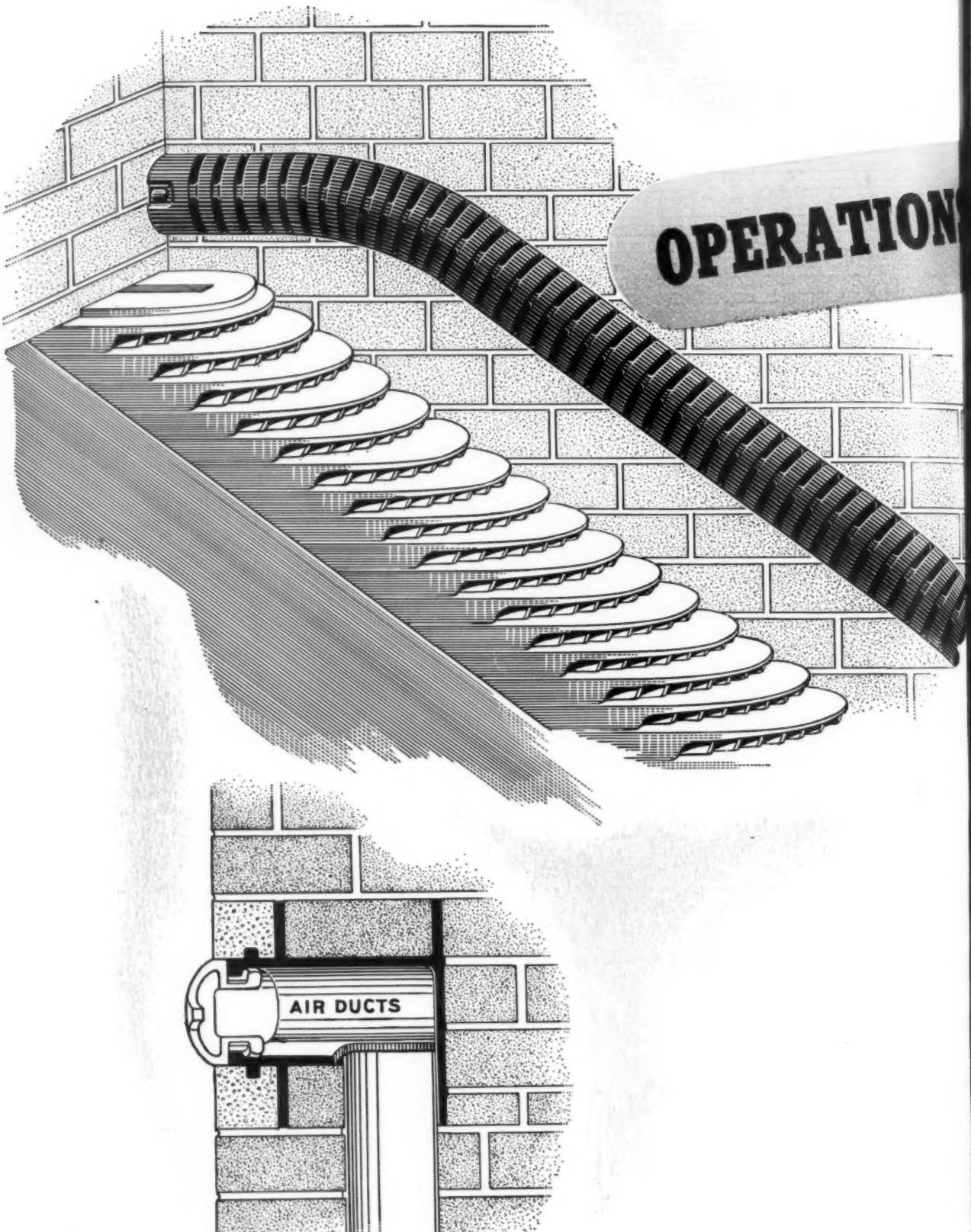
THIS IS NUMBER NINE in a Series of Scovill Advertisements to help you get longer life from condenser and heat exchanger tubes.

Scovill
MANUFACTURING COMPANY
WATERBURY, CONN.

SCOVILL CONDENSER TUBES

ONE PRODUCT . . . THREE SERVICES

Service in Manuals . . . Service in Metals . . . Service in Men


OPERATIONS
AIR DUCTS

MPROVED THESE 5 WAYS WITH

TAYLOR SIDE WALL AIR NOZZLES

WHERE water walls are not justified, the formation of clinkers on furnace side walls is a time-wasting and costly annoyance. Happily, however, there is a solution for these difficulties—Taylor Side Wall Air Nozzles. These nozzles, a product of years of Stoker engineering development, continually discharge a uniform screen of air that reduces side wall clinker formation. Stoker efficiency goes up, cost comes down.

At the same time Taylor nozzles offer other interesting features favoring economical operation, and reduced replacement and maintenance costs.

1. They are set in side walls below the hot zone and are at all times air cooled resulting in minimum maintenance and simplicity of replacement.
2. Brick work maintenance and labor costs are reduced due to counteracting of flame action and damage caused by hand removal.
3. Elimination of loss that occurs when boilers are off the line for repairs at other than regular cleaning periods.
4. Effect an increase in furnace capacity, making available space occupied by clinkers.
5. Operators find equipment more satisfactory, resulting in better performance. This simplifies the problem of getting and keeping the class of men you want.

The Side Wall Air Nozzle is one of many Taylor Stoker features combining to generate steam efficiently at a lower cost.

JUDGE THE SELECTION OF FUEL FIRING EQUIPMENT BY THESE TWELVE POINTS

1. RELIABILITY—the ability to operate with minimum outage and minimum standby equipment.

2. CAPACITY—the ability to provide adequate prime capacity ratings, with sufficient reserve capacity for emergencies.

3. MAINTENANCE—the ability to operate continuously with minimum repair costs.

4. FLEXIBILITY—the ability to follow the steam demand upward or downward . . . quickly and without sacrificing efficiency.

5. EFFICIENCY—the proved dollar efficiency (total cost of steam production) as shown by actual performance in similar installations.

6. OPERATION—the ability to operate continuously, the number and type of operations required, the ease of combustion adjustments, etc.

7. ADAPTABILITY—the ability to meet special and limiting conditions, present and future—structural limitations, utilization of present equipment, growth and change of power service demands.

8. FUEL FLEXIBILITY—the ability to burn efficiently and easily fuels from many sources having widely varying characteristics.

9. REFUSE DISPOSAL—the ability to economically eliminate ash or refuse and the opportunities of disposal at low cost, no cost, or profit.

10. STACK DISCHARGE—the practical elimination of "smoke nuisance" without special equipment.

11. SPACE REQUIREMENTS—the ability to conform to existing or future space limitations, to short and wide or long and narrow furnaces. Also the accessibility of component parts for maintenance and operation.

12. OBSOLESCENCE—the adaptability of the equipment toward possible future modernization with minimum of complication and outage.

A-E-CO TAYLOR STOKERS • LO-HED HOISTS
HELE-SHAW FLUID POWER • MARINE DECK AUXILIARIES

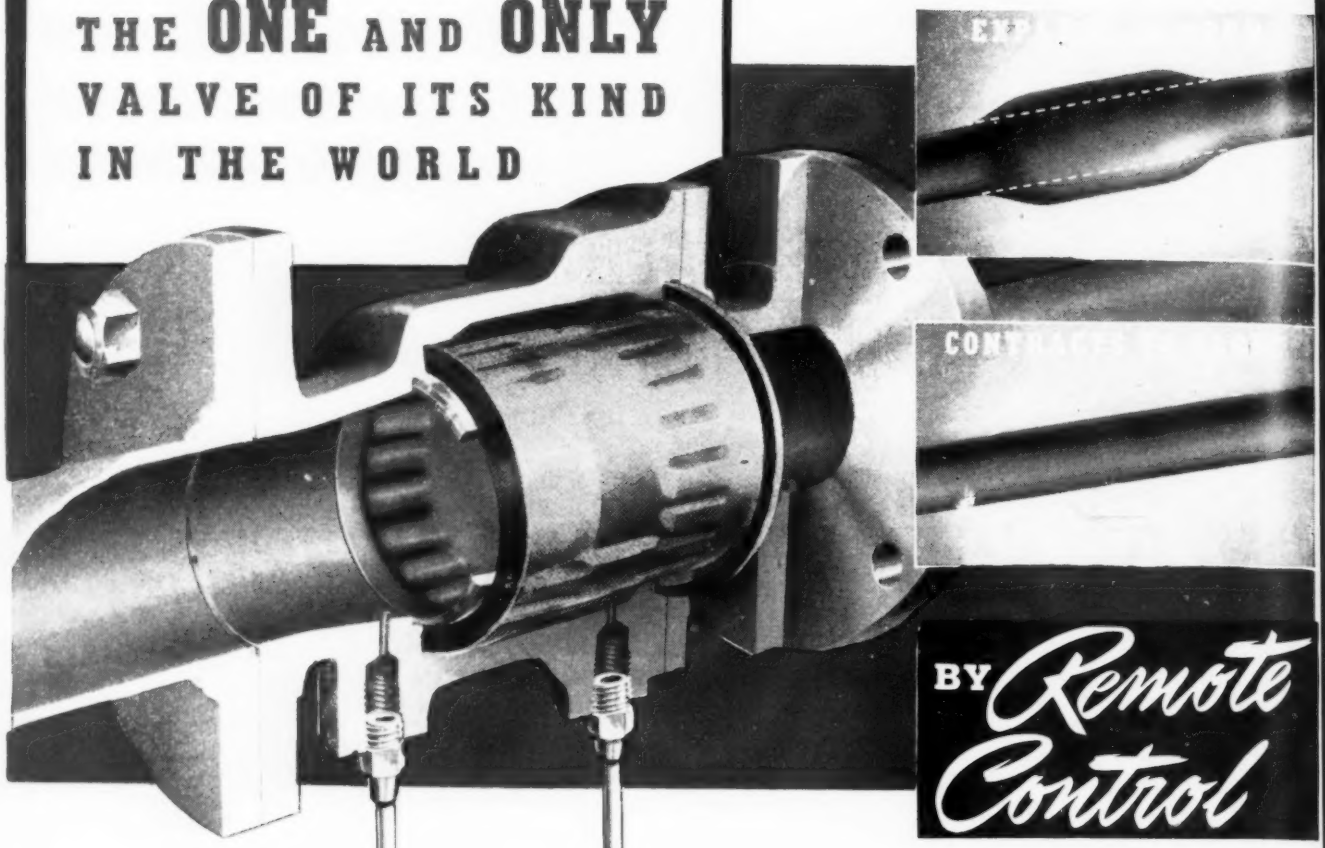
A-E-CO TAYLOR STOKER

Æ CO 75

AMERICAN ENGINEERING COMPANY

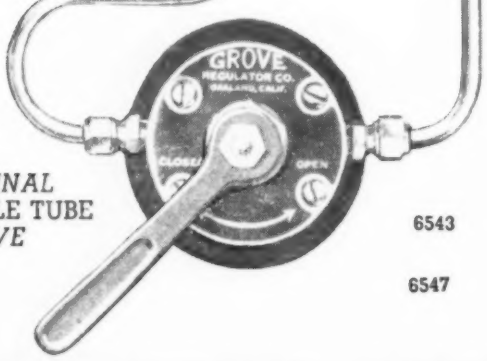
PHILADELPHIA 25 • PENNSYLVANIA

THE ONE AND ONLY VALVE OF ITS KIND IN THE WORLD



BY Remote Control

★ Takes up no more headroom than a pipe
★ Insures a positive Bubble-tight, Air-tight shut-off
★ Provides a smooth non-turbulent streamline flow.



THE *ORIGINAL* EXPANSIBLE TUBE TYPE *VALVE*

6543

6547

Grove Flexflo Remote Control Valves represent a distinct and radical departure from conventional types of valves, in design, construction and operation. Designed for cold fluid service, these new valves are especially suited for handling water, salt water, chemical solutions, oil, gases and air. With but one non-metallic operating part they are extremely resistant to corrosion, erosion and electrolytic action. Moreover, they are automatically self compensating for wear. Contrasted to mechanically operated valves, the Grove Flexflo operates by manual or automatic remote control on hydraulic or pneumatic fluid line pressure—expanding to open—contracting to close. For full details write today for Bulletin 800.

GROVE *flex-flo* REMOTE CONTROL

GROVE
SIMPLICITY
ACCURACY
SAFETY

GROVE REGULATOR COMPANY
6547 GREEN STREET, OAKLAND 8, CALIFORNIA. *Branch Offices:* 30 Rockefeller Plaza, New York 20 • 5644 Navigation Boulevard, Houston 11, Texas • 1930 West Olympic Boulevard, Los Angeles 6, California

WRITE TODAY FOR BULLETIN 800

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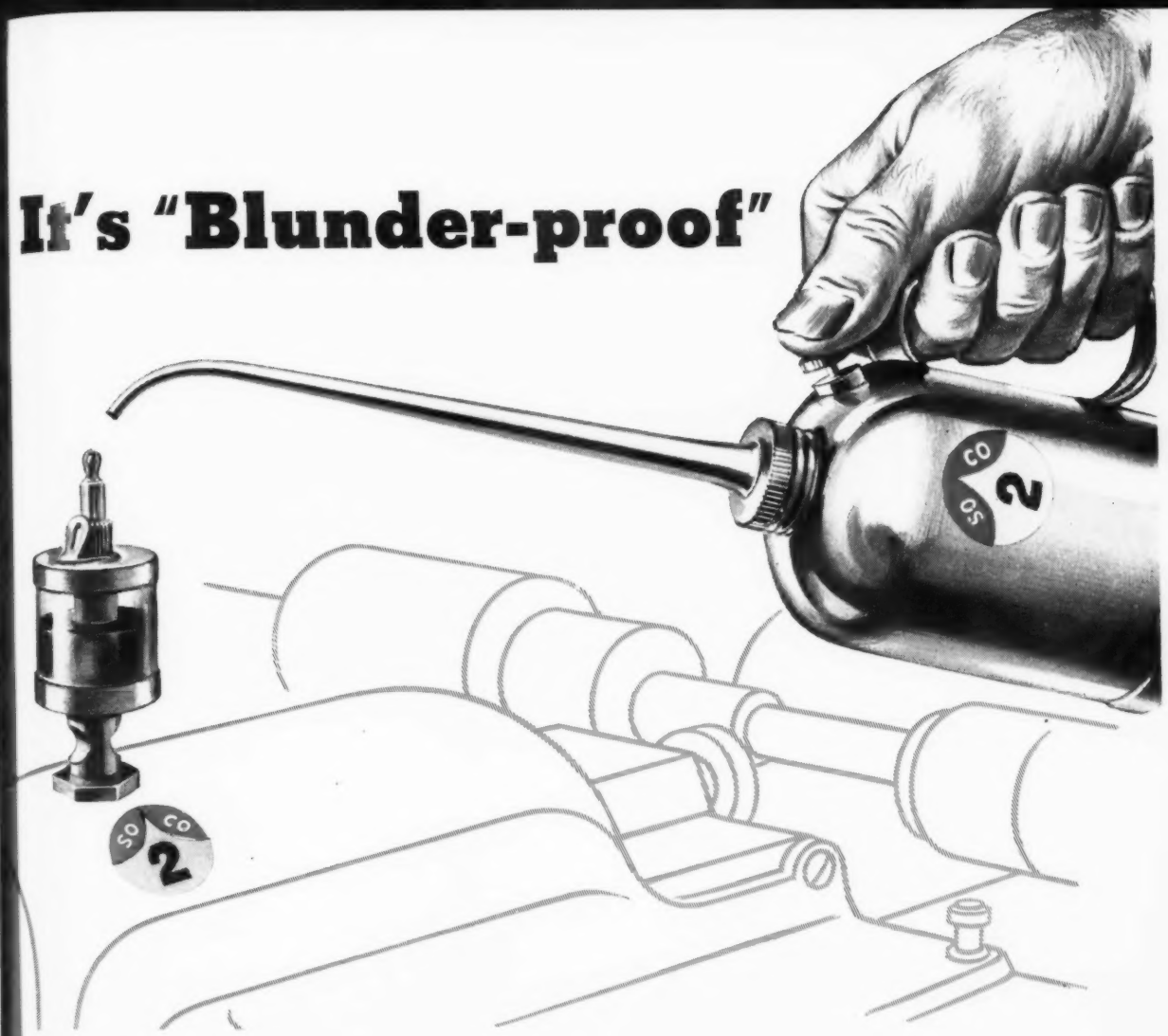
S

It's "Blunder-proof"



Announcing...

Standard Coded Lubrication Service

...planned to get the right lubricants to all the right places!

NO ONE KNOWS better than the man in charge of your lubrication, the *need* for this simple, "blunder-proof" code system.

Under this plan, every lubricant used in your plant is given a code number (Nos. 1, 2, 3, etc.). *Every* lubrication point throughout your plant is clearly marked with a bright decalcomania bearing the code number of the lubricant to be used there. This code number is also put onto *every* container—drum, barrel, dispenser, funnel, oil can, or grease gun containing that lubricant.

When this simple code system is followed, no point of lubrication can receive the wrong lubricant—no point can be missed.

Ask the Standard Oil Man to give you full details of Standard Coded Lubrication Service. Call the nearest Standard Oil office and ask for an Engineer or Representative. This Coded Service is at *your* service—without cost—whether your plant is a large user, small user, or non-user of Standard Oil products.

Considerable advance demand was created when this plan was first submitted to representative industrial groups. Materials are being produced as fast as wartime conditions permit. We suggest you get your request on file at your nearest Standard Oil office.

Oil is Ammunition... Use it Wisely

STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

SEE OTHER SIDE FOR DETAILS

LUBRICATION ENGINEERING...LUBRICATION ENGINEERING...LUBRICATION ENGINEERING...LUBRICAT

G...LUBRICATION ENGINEERING...LUBRICATION ENGINEERING...LUBRICATION ENGINEERING...LUBR

How Standard Coded Lubrication Service goes to work in your plant

Here is your equipment. Call in your Standard Oil Engineer to start you off right!

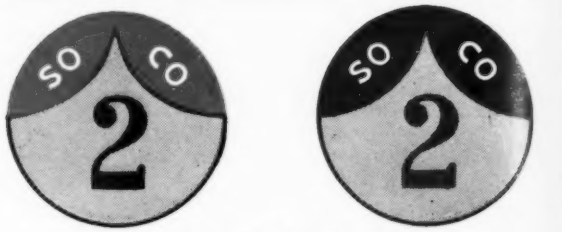
AT THE MOMENT when highest productive capacity is expected of every machine—when utmost protection of equipment and parts is essential—and when many of the best-trained oiler crews have been shot to pieces by wartime upsets—Standard Oil comes forward with this simple, practical *Coded System* for correct lubrication of every part.

Note that this is a *numerical* system—not to be confused with complex "color scheme" systems sometimes proposed. Here is the "complete package" furnished by Standard Oil—simple as A, B, C.

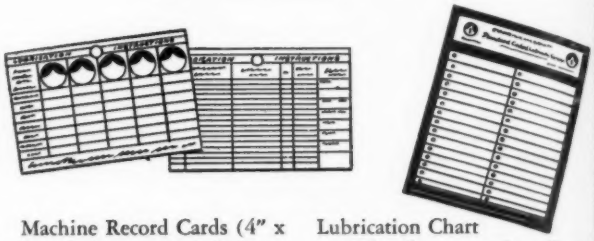
A: Numbered Decalcomanias: Furnished you in quantity sufficient to apply to every point of lubrication, every container, and every servicing device in your plant. Two color schemes (red-and-yellow and blue-and-yellow) may be used, if desired, to distinguish operator-lubrication points from points lubricated by the maintenance crew; or greases from oils; or "every shift" points from points lubricated at longer intervals, etc.

B: Machine Record Cards: Where desired, a supply of machine record cards (4" x 6") is provided. The card may be kept in the files. One side carries the lubricant code numbers required for that particular equipment, number of points to be serviced and frequency of application. The reverse side furnishes names of parts to be lubricated, together with specific details of each machine.

C: Lubrication Chart: For control purposes, a card is filled in by the Standard Oil Lubrication Engineer with brand name and code numbers of all lubricants used in the plant. This chart is used by stock clerk or stockkeeper to enable him to requisition products by brand name, and to mark barrels with the correct decal.



Decalcomanias in two-color arrangements (red-and-yellow and blue-and-yellow) mark every lubrication point, dispenser, and container.



Machine Record Cards (4" x 6") designate the lubricants to use, number of lubrication points, and frequency of application.

Lubrication Chart provides for convenient listing of all lubricants used, by brand name and grade—plus code number assigned to each.

Fits into your present system—Standard CODED Lubrication Service can readily be fitted into whatever lubrication plan is now in effect in your plant. It is carefully planned to simplify, not complicate, your lubrication problems.

It not only makes easier and more effective the work of your oiler crews—makes it virtually impossible for inexperienced oilers to misapply lubricants—but also it immediately clarifies and simplifies the efforts of the *men in charge* of this important part of your operations.

Call your nearest Standard Oil Engineer or Representative . . . let him go over this plan with you in simple detail, and work out its immediate application in your plant. This Standard Coded Lubrication Service is a contribution to better lubrication, and is at your service entirely without cost. If your plant is in the Middle West, call your Standard Oil Engineer, or write Standard Oil Company (Indiana), 910 S. Michigan Avenue, Chicago 5, Illinois. In Nebraska, write Standard Oil Company of Nebraska at Omaha 2.

Oil is Ammunition . . . Use it Wisely

STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

(Here's another ad in the series that brings a vital message to your customers.)

In postwar planning...

HOW is just as important as WHAT

NO MANUFACTURER can predict all the new products he will make in the next decade. But he does know that new and improved methods of *producing* them are already here—methods calling for increased use of electric power.

That's why far-seeing management is attaching such importance to *adequate wiring* . . . seeing that it's a basic part of all postwar planning. They realize that tomorrow's competitive position will depend more than ever on electric energy . . . *and adequate wiring to harness it.*

Right now is the time to find out how *your* plant's wiring system measures up . . . what it needs to meet postwar requirements. By all means, bring your electrical contractor and utility power engineer into the advance planning stage. *Unwired* planning will cost you a lot more than *planned wiring.*

ADEQUATE WIRING — KEY TO POSTWAR BUSINESS — SERVES AND SAVES

44224

HELP BRING VICTORY SOONER . . . BUY MORE WAR BONDS

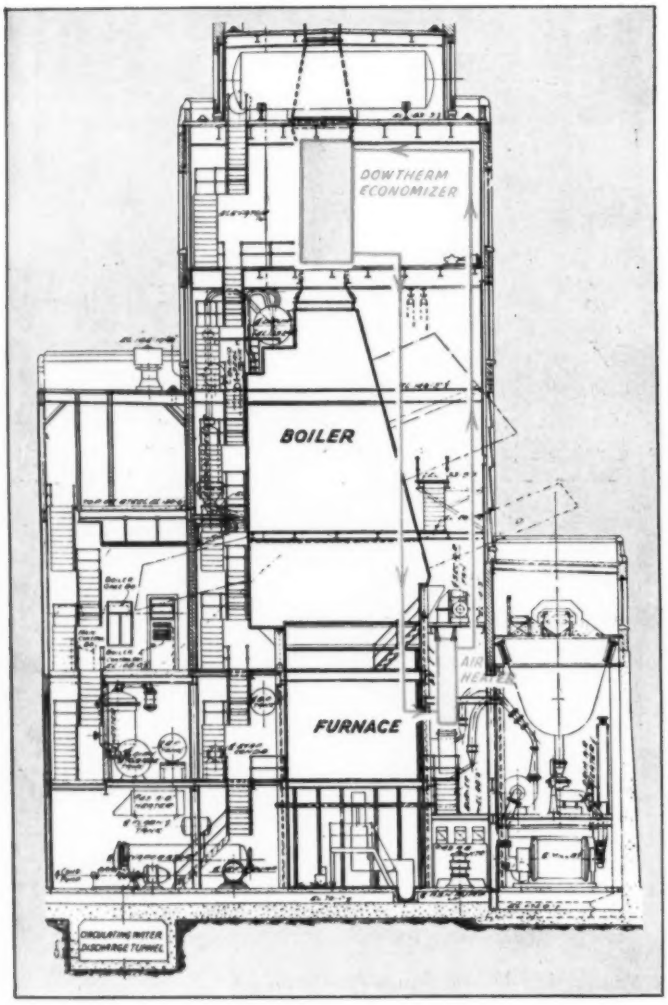
ANACONDA WIRE & CABLE COMPANY

25 Broadway, New York 4 . . . Sales Offices in Principal Cities

Electrical Wires and Cables of Copper are the Life Lines of our Nation

Blazing THE

DOWTHERM ECONOMIZER FOR AIR-PREHEATING



• Complete elimination of large preheater air ducts extending from above the boiler to the firing floor, 100 feet below, has been effected at the Bremo Station of the Virginia Public Service Company. The customary air heater, located over the boiler, was replaced by an economizer heating Dowtherm (not water) to 500°F. The hot Dowtherm is pumped down through small diameter lines to the burners, where it is used as the heating medium in tubular air preheaters. Besides doing away with cumbersome ducts, this system reduces radiation losses and gives individual control of primary and secondary air temperatures.

Foster Wheeler is a Three-Star winner under the U. S. Navy Board of Awards for production

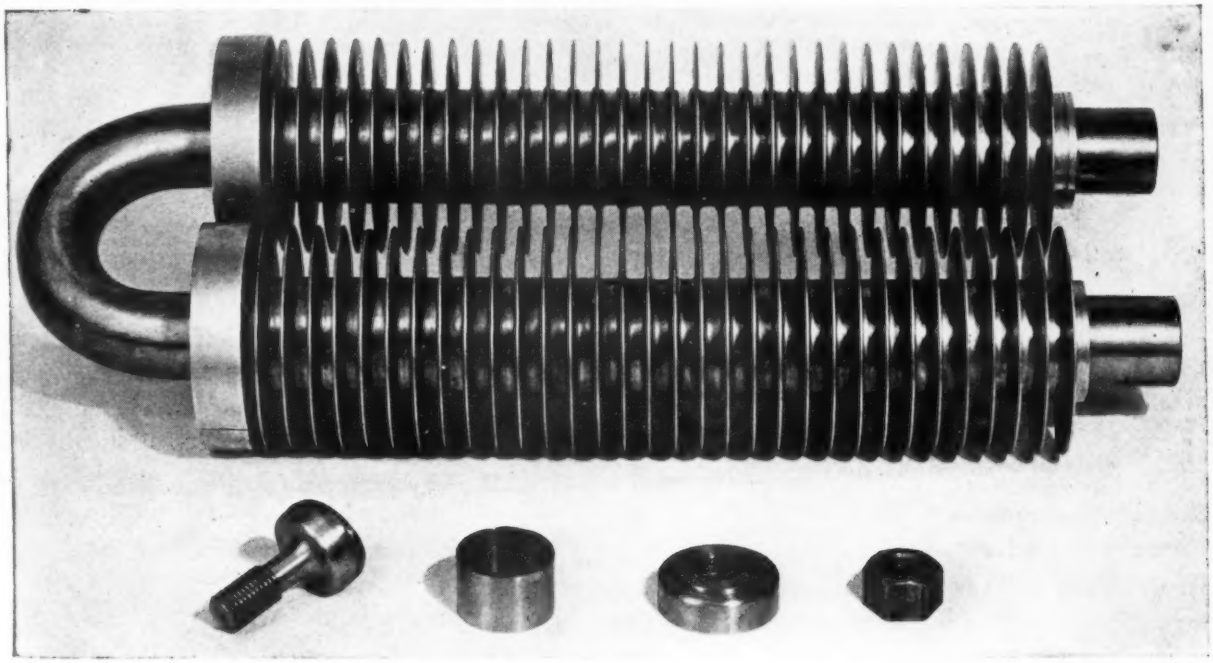
FW FOSTER

ENGINEERING TRAIL

ALUMINUM RING ECONOMIZERS

• Twenty-four years ago, Foster Wheeler designed and commercialized the cast iron extended surface ring economizer. Performance of this high efficiency unit made it a "natural" for marine service—but its weight proved prohibitive. Exhaustive research solved the problem and a comparable light weight aluminum ring design, suitable for high pressure, was developed for the U. S. Navy.

Nine times the surface of bare tubes per lineal foot, exceptional lightness, minimum space requirements and remarkably low maintenance caused its application to merchant ships as well. The aluminum ring economizer is the finest construction in marine engineering.



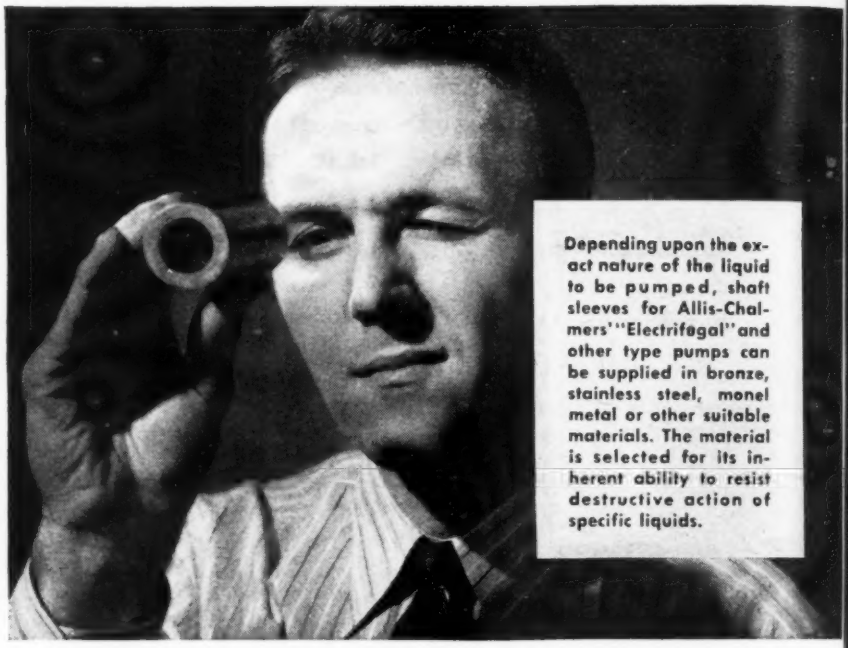
FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, N. Y.

WHEELER FW

[PUMP TIPS FROM ALLIS-CHALMERS—ONE IN A SERIES]

How to make SLEEVES Last Longer . . .



Depending upon the exact nature of the liquid to be pumped, shaft sleeves for Allis-Chalmers' "Electrifugal" and other type pumps can be supplied in bronze, stainless steel, monel metal or other suitable materials. The material is selected for its inherent ability to resist destructive action of specific liquids.

AS WITH MANY pump troubles, excessive sleeve wear is apt to trace back to misalignment of pump and motor. For when shaft is deflected, sleeve is apt to wobble within the packing — accelerating friction and wear.

So serious is this problem of misalignment, that Allis-Chalmers engineers were led to develop, for many applications, the famous "Electrifugal" pump — in which both the motor and pump impeller are mounted on one shaft and in one frame.

In such a pump the elements cannot get out of line — and danger of excessive sleeve wear is minimized. However, many pumps in use today are separate from their driving motors — and the coupling flanges must be carefully aligned . . . and *kept* in alignment!

Here are other ways to extend sleeve life:

▶ Don't draw stuffing box gland too tightly . . . excessive pressure will wear shaft sleeves unduly.

▶ Never pump a liquid for which your pump was not designed. Sleeves are able to withstand corrosive effects of some but not necessarily all liquids. When in doubt over safety of changing pump application, check with your manufacturer.

▶ Generally a thin stream of liquid being pumped serves as a water seal between packing and sleeve. If it is dirty or abrasive, a separate supply of sealing liquid should be obtained. And it should reach the sleeve in a steady supply. Be careful water seal piping isn't plugged — or lantern ring displaced.

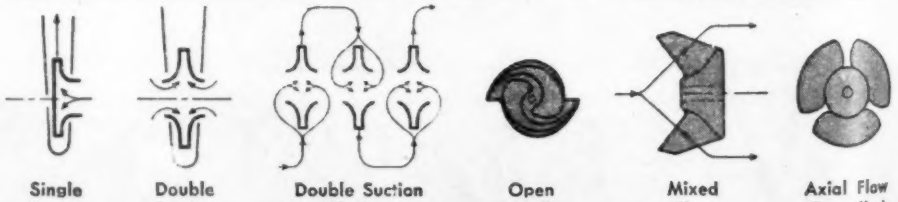
▶ Send for your *free* copy of Allis-Chalmers' "Handbook for Wartime Care of Centrifugal pumps". This valuable booklet applies to *all* makes of pumps. ALLIS-CHALMERS MFG. CO., MILWAUKEE 1, WIS.

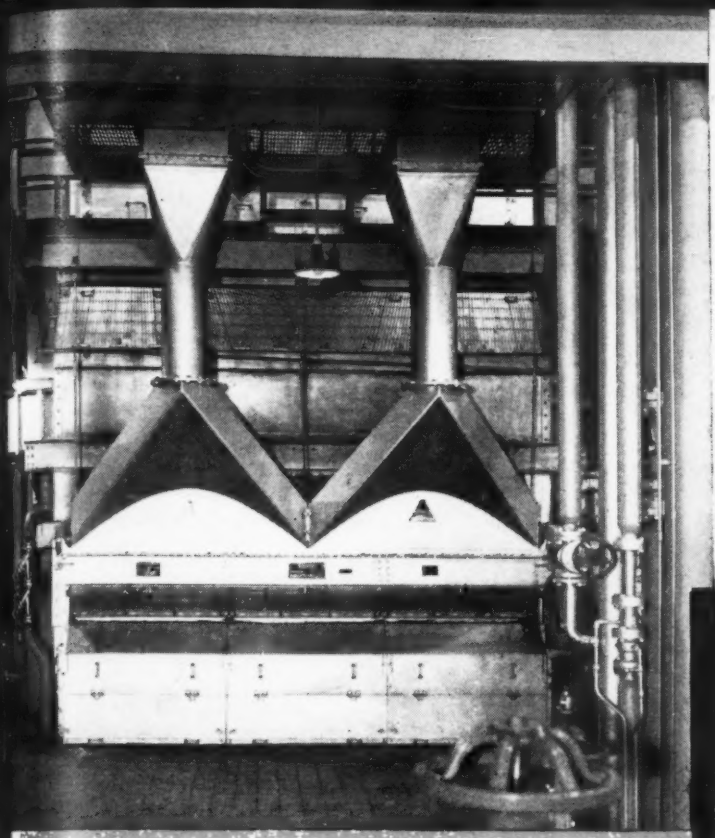
♪ *Tune in the Boston Symphony, Blue Network, every Sat. Eve.*

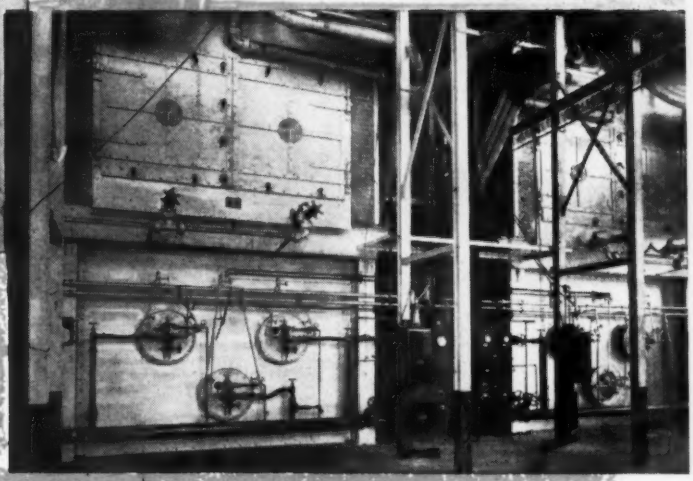
A 1708

ALLIS-CHALMERS PUMPS

Allis-Chalmers builds all types and variations of pumps shown at right. Capacities from 10 to 150,000 gpm—heads to 2500 lbs.







ELECTRIC STEEL HEADERS

... improve sectional boiler design

Another of the outstanding features that Springfield has pioneered in water-tube boiler design is the use of electric-furnace cast steel for boiler, water wall, superheater and economizer headers —which gives Springfield boilers a much broader field of application than ordinary sectional header designs.

Flexibility in design is secured at nominal cost by modifying patterns to meet desired conditions, and uniform strength is secured throughout the entire header structure by increasing casting thickness or incorporating reinforcing ribs as required. The casting process also makes possible a wide variety of header designs to assure correct design for each boiler application.

This electric furnace cast steel complies with all construction code requirements. Chemical analysis and physical properties are under careful control and are carefully checked by laboratory tests on each heat. All castings are fully annealed. Carbon steel used for most Springfield boilers under 600 lbs. working pressure tests 72,000 lbs. per sq. in. minimum tensile strength. For higher pressures, alloy steel is used that ranges from 85,000 to 105,000 lbs. tensile strength.

Other advantages: Tougher metal in headers to resist tube rolling and to form tighter and stronger rolled connections. The tensile strength and yield point of Springfield electric steel is 25% greater than the usual forged or wrought steel. No seams or crevices are present to provide starting points for caustic embrittlement or corrosion, and the cast surfaces are corrosion resistant. Pitting or corrosion has never been reported in Springfield headers.

Springfield sectional header boilers are worthy of serious consideration on any modern boiler project.

SPRINGFIELD BOILER COMPANY

1953 E. Capitol Avenue • Springfield, Illinois

SPRINGFIELD

MODERN STEAM GENERATING UNITS

FOR 9 OUT OF 10 STOKER JOBS

SKELLY STOKER

Unquestionably the quality stoker in its field. Serving industrial plants, office and apartment buildings, schools, laundries and the like in every section of the country. Available in designs for either anthracite or bituminous coals. Its long record of success in burning a wide variety of bituminous coals has been matched in recent years by hundreds of anthracite installations.

SPREADER STOKER

The remarkable acceptance of the C-E Spreader Stoker is indicated by the fact that in the six years it has been on the market C-E Spreaders have been purchased to serve boilers having an aggregate capacity of nearly 10,000,000 lb of steam per hour. They are serving from Alaska to the southernmost part of Chile, in China, Russia, Australia and 26 states in the U.S.A. from Maine to Oregon.

TYPE E STOKER

The Type E Stoker is one of the best known and most widely used in the world, serving substantially more boiler heating surface (over 14,000,000 sq ft in American plants alone) than any comparable stoker. Those who know it through experience continue to buy it as evidenced by the fact that over 35 percent of all Type E contracts are repeat orders.

ONE OF THESE 3 C-E TYPES

is the best answer

Single Retort Underfeed and Spreader Stokers are far and away the most widely used types these days, accounting for about 90 of every 100 stokers installed under boilers rated from 50 hp up.

The high percentage of C-E Stokers selected in this category is indicative of how well these three types, described here, blanket this field.

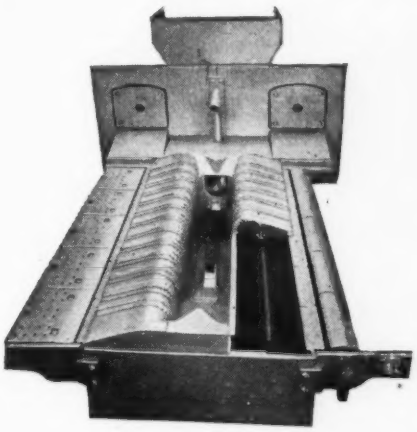
And for the remaining 10 percent, C-E also has the right answers in its modern designs of Multiple Retort, Traveling and Chain Grate Stokers,—all of them leaders in their respective fields.

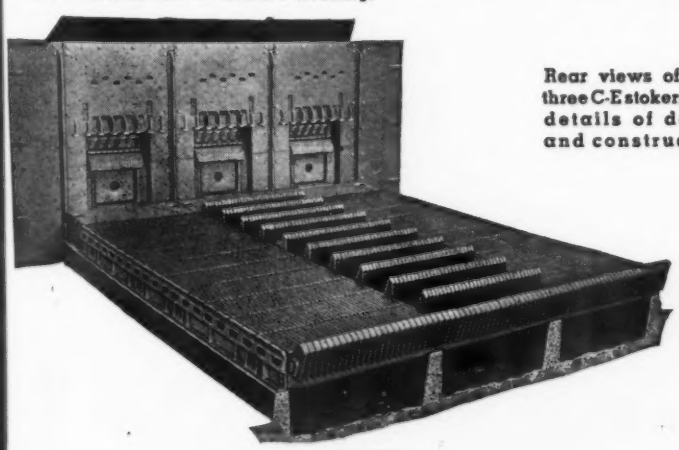
So whether your plant is one of the 90 percent group or one of the 10 percent, you can turn to C-E with complete confidence that you will get the right answer for your requirements. You will also have the satisfaction of knowing that your stoker reflects the experience accumulated in installing over 18,000 stokers of all types, above residence size, to serve about 5,000,000 rated boiler horsepower. This is Combustion Engineering's record to date and no other stoker manufacturer in the country can match it. A-774

SKELLY STOKER (upper right)
Approximate Application Range — 20 to 200 boiler hp. A compact, self-contained unit offering all the advantages of underfeed firing. Moving grate bars assure lateral distribution of fuel and maintain a clean porous fire. Cantilever dump grates of non-avalanching type simplify ash removal. Integral forced-draft fan, with vortex inlet control, permits positive regulation of air-coal ratio. Sixteen rates of coal feed through variable-speed transmission. Automatic control is standard equipment. Timken bearing equipped. Alemite lubrication throughout.

TYPE E STOKER (lower right)
Approximate Application Range — 150 to 600 boiler hp. A single-retort, underfeed stoker designed to burn a wide variety of bituminous coals. Ram feed is supplemented by a reciprocating sliding bottom. Grate surface consists of hollow, air-cooled grate bars, alternately fixed and moving, to condition the fuel bed and assure its steady movement toward the dump trays. Air supply under zoned control with provision for introducing air over the fire. Steam or hydraulic drive.

SPREADER STOKER (lower left)
Approximate Application Range — 150 boiler hp to largest units suitable for stoker firing. A simple, rugged stoker designed to burn a wider variety of fuels than any other type of mechanical firing. Hopper, feeding and distributing mechanism, variable-speed drive and motor are combined in a compact unit. Rotating spreader blades feed coal into the furnace in crisscrossing streams which assure uniform distribution. Fines are burned in suspension and the rest of the coal is burned on a grate — either stationary or dumping type. Grate surface is zoned for regulating air admission and to facilitate cleaning.

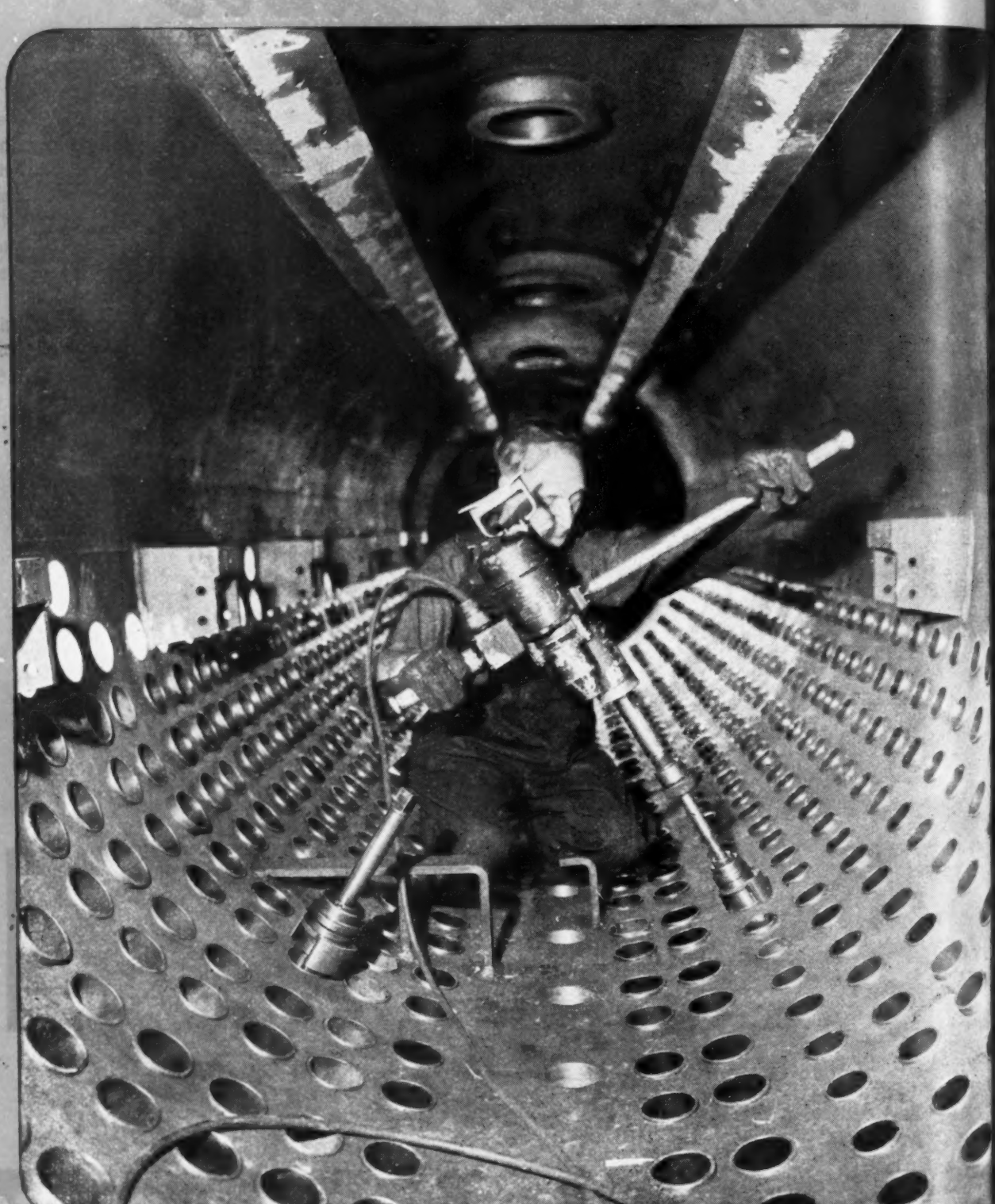




Rear views of these three C-E stokers show details of design and construction.

COMBUSTION ENGINEERING
200 MADISON AVENUE, NEW YORK 16, N. Y.

Why You



Should Specify

ELECTRUNITE BOILER TUBES

Electric resistance welding, as employed in the manufacture of Republic ELECTRUNITE Boiler and Heat Exchanger Tubes, is the *only* process today which *consistently* produces tubes with these advantages: (1) uniform roundness; (2) uniform diameter; (3) uniform wall thickness; (4) uniform high ductility; (5) smooth surface uniformly free from scale and scale pits; (6) uniform freedom from concealed defects.

ELECTRUNITE Boiler and Heat Exchanger Tubes are made from flat-rolled steel which is closely inspected on both sides. It then is cold formed into a round butted shape and electric resistance welded into a sound, strong tube, homogeneous in structure *and with a weld as strong as the wall.*

Controlled atmosphere normalizing produces uniform, high ductility without disturbing the smooth, scale-free surface. Rigid tests regularly made after every step in the manufacturing process insure safety in every tube.

Because of these advantages, ELECTRUNITE Tubes slide through sheet holes without difficulty —expand and roll to tight fits easily and quickly —make positive joints—reduce installation costs—retard corrosion—assure safe service and low maintenance cost. More than 120,000,000 feet in service prove these statements.

Some 30,000 miles of Republic Line Pipe, 50,000,000 feet of oil well casing and tubing, and more than 1,000,000,000 feet of aircraft and mechanical tubing in carbon, low alloy and stainless steels, produced by the same process, have proved *indisputably* the soundness, safety and economy of electric weld tubular products.

Write for descriptive literature.

REPUBLIC STEEL CORPORATION
Steel and Tubes Division
Sales Offices · Cleveland 8, Ohio
GENERAL OFFICES • • CLEVELAND, OHIO
Berger Manufacturing Division • Culvert Division
Niles Steel Products Division • Union Drawn Steel Division
Truscon Steel Company
Export Department: Chrysler Building, New York 17, New York

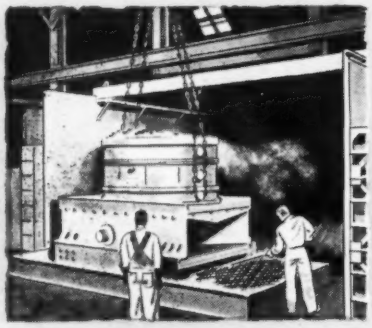
REPUBLIC STEEL CORPORATION, STEEL AND TUBES DIVISION, IS THE ONLY PRODUCER OF ELECTRUNITE TUBING.

Republic
ELECTRUNITE
Reg. U. S. Pat. Off.
BOILER, CONDENSER AND HEAT EXCHANGER TUBES

Be sure "AIR-AT-WORK"

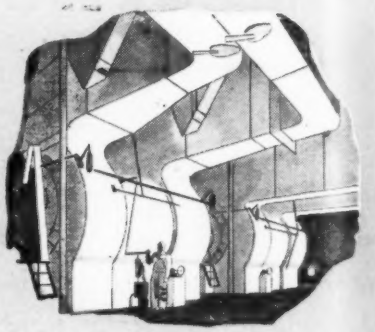
POST WAR PLANNING

A year ago it was unpatriotic to mention the word. Today it is industry's greatest challenge. A challenge that AIR-AT-WORK can help you meet—every step of the way—from designing a better product to making it more efficiently and improving the conditions under which it is made. Sturtevant Engineers have the knack of putting a finger on the *right* spots for air handling equipment. We invite an opportunity to sit down and discuss these applications in terms of *your* operations and products—without obligation.



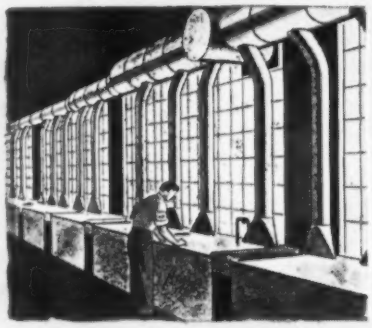
AIR to grab dust and keep it away from men and machines

Wherever dust will be created, Sturtevant has a special method of keeping it in line, safeguarding both employees and equipment, minimizing the cost of operation. For example, instead of carrying off and wasting heated room air, a new technique whirls it through dust separators, and returns the clean air to the room with all its valuable heat intact.



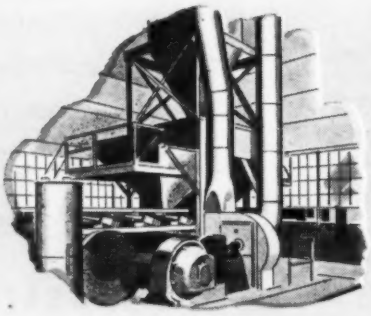
AIR to squeeze the last atom of energy out of your fuel

For tomorrow's power plant boilers, look to Sturtevant for the mechanical draft fans that will meet the demands for higher speeds, large volumes, highest pressures, temperatures and efficiencies. For example, new cyclone furnaces utilize Sturtevant centrifugal compressors to supply air for combustion at 70" pressure.



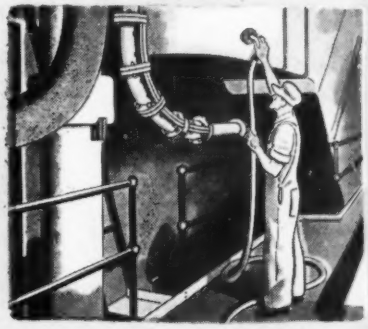
AIR to blast out fumes that keep you less than 100% efficient

If there's even a trace of fume or fog in your plant, look to Sturtevant for improved methods of holding it in check, adding years to the life-expectancy of both men and machines. For example, concentrations of acid fumes which formerly restricted production are now precision-controlled. Production line methods are possible without jeopardizing operators or equipment.



AIR to carry hard-to-handle materials with no waste motion

For handling any sort of loose material, Sturtevant has a pneumatic conveying system that picks it up and lays it down where it belongs without loss or labor. For example, an extra twist that Sturtevant gives one problem not only delivers light yet bulky materials throughout the plant, but thoroughly cleans them of dust and dirt en route.



AIR to spruce up your plant with a minimum of cost and labor

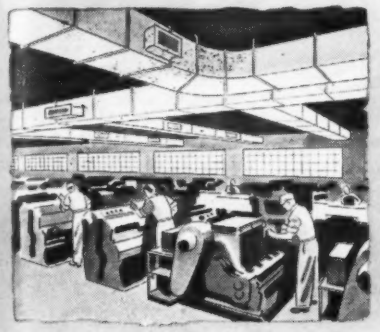
In meeting new standards of plant cleanliness, Sturtevant is headquarters for portable and central system Vacuum Cleaners that ferret out dirt faster, easier, more efficiently. For example, improved methods of reaching into racks, bins and machinery, up to rafters, pipes and ledges, offer new opportunities to minimize health and production hazards, fire and explosion dangers and even to reclaim valuable dust.

Sturtevant Equipment AND SYSTEMS

REG. U. S. PAT. OFF.

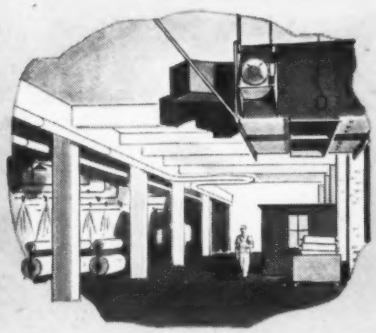
sits in on your

POST WAR PLANNING COMMITTEE!



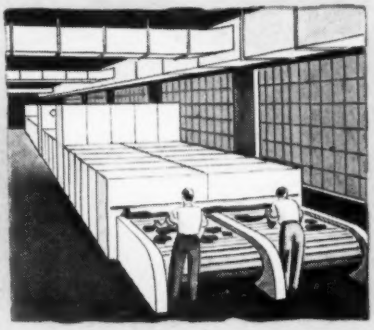
AIR to harness the weather to your production needs

For processes that must pay more attention to indoor weather, Sturtevant is ready with improved equipment and systems that permit matching the installation to the budget and process involved. For example, in the manufacture of ultra-precision instruments, air conditioning controlled within one degree of temperature and humidity makes possible assembly and test adjustments within tolerances of one millionth of an inch



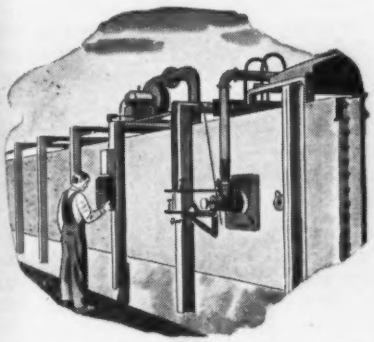
AIR to make every ounce of steam pay off in useful heat

In heating your plant tomorrow, count on Sturtevant for equipment and systems that put heat in the right places at the right temperature, cutting fuel bills in the bargain. Because Sturtevant manufactures all three types of unit heaters as well as central systems, we know what each can do best and which one or combination is best suited to your job.



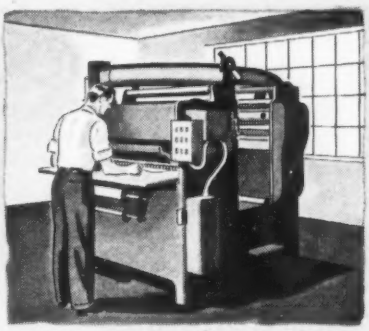
AIR to carry moisture out of your product more efficiently

In drying or dehydrating tomorrow's products, Sturtevant has developed new techniques for extracting moisture in a way that will increase output and improve product quality. For example, an ingenious arrangement of either tapered nozzles and baffle plates or perforated plates and plenum chamber now produces a change of heated air up to 300 times a minute near the material being dried.



AIR to boost up the pressure needed for special process work

When it's time to review production costs again, come to Sturtevant for suggestions and methods of utilizing a blast of high pressure air for closer control of combustion, cooling, drying, cleaning, agitation of liquids and countless other processes For example, compressors now supplying a constant weight of air to foundry cupolas affect closer control of combustion, improved quality of castings.



AIR to help give your new products a jump on competition

Have you considered how air handling equipment, incorporated in your post-war product, can improve machine performance and product quality? For example, a blue print machine produces better prints faster with a specially designed and applied fan which exhausts heated air from the light chamber and uses it for drying prints more rapidly and uniformly

Why not discuss it with us *now*?

Sturtevant has long experience with ALL types of problems that *air at work* can solve . . . Sturtevant makes a wide range of equipment — and knows which can best lick any ONE problem. Add it up and you have the right place to bring your post-war problems. A Sturtevant Engineer is ready and waiting to discuss your particular needs—and to submit competent recommendations.

B. F. STURTEVANT COMPANY
HYDE PARK BOSTON 36, MASS.
Branches in Principal Cities

Engineered for Efficiency

IN HEATING, VENTILATING, AIR CONDITIONING, DRYING, DUST AND FUME CONTROL, PRESSURE BLOWING, VACUUM CLEANING, PNEUMATIC CONVEYING AND MECHANICAL DRAFT

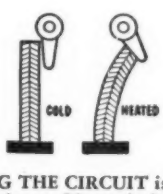
Hot arcs stopped *Cold!*

A circuit breaker must work fast . . . pass harmless overloads without interruption . . . yet when danger threatens, it must open the circuit and quench the arc—quick!

Westinghouse "De-ion" Circuit Breakers do this—and protect themselves, too—burns and pits are minimized, contacts last longer.

To restore service instantly, once the disturbance is cleared, simply flip the indicating handle. No waiting—no repairs—no parts to replace.

Protect equipment and circuits with Westinghouse "De-ion" Circuit Breakers. Ratings up to 600 amperes; enclosures for nearly every type of service. Call your Westinghouse Representative today. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., Dept. 7-N. J-21297



DEFENDING THE CIRCUIT is the job of this Westinghouse Bi-metal element. Two metals which react differently to heat are bonded together. Threatening overloads cause the Bi-metal to bend, tripping the interrupting mechanism and opening the circuit—*before* any damage is done.

STOPPING ARCS COLD is the task of the "De-ion" arc quencher . . . consisting of parallel metal plates in the form of a grid. It draws the arc into the quenching chamber, divides it into segments . . . smothers it between the plates . . . in the space of a half cycle.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

"DE-ION" CIRCUIT BREAKERS

Hardness

...WHAT IT MEANS IN A METAL
WHAT IT MEANS TO A METAL USER

Next to strength, the property usually most sought in a metal is *hardness.*

A dictionary calls a material hard when it is "not easily penetrated, cut, or separated into parts, not easily yielding to pressure."

Others call it "the ability to resist plastic deformation," and "resistance to indentation or penetration."

In short, an exact definition of hardness seems to have stumped even Webster.

What hardness *is,* however, is not so important as what it *does.*

Generally, the harder a metal, the greater its resistance to frictional wear, the better it fights the blasting action of grit and other abrasive substances, and the longer it holds off the erosive effect of steam or water. A hard metal usually does not gall or seize as quickly as a softer one.

Though hardness must share credit with toughness and ductility for resisting most forms of wear, hardness usually gets the nod as the most important of the three.

Since no one method of hardness testing is applicable to all shapes of materials, several types of testing machines have been developed. Of these, the Brinell, Rockwell and Vickers machines are basically similar, as all measure penetration of the metal under test . . . by ball, cone or pyramidal indenter. The Scleroscope measures hardness by the "bounce" of a diamond-tipped hammer.

As a group, the INCO Nickel Alloys are in the upper hardness range, varying from medium to very hard, as shown in the chart at the bottom of this page.

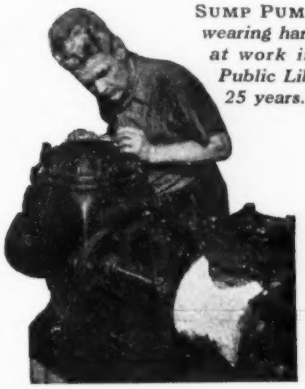
Note the exceptional hardness of "K" Monel, "Z" Nickel, and "S" Monel.

"K" Monel can be heat-treated after finishing, for applications that require a corrosion-resisting material with extremely high strength and hardness. "S" Monel is an extremely hard and strong cast alloy for non-galling valve trim, pump liners, etc. It retains high hardness at red heat. "Z" Nickel, one of the hardest non-ferrous alloys obtainable, can be heat-treated after forming to develop 2½ to 4 times the strength of structural steel.

The practical advantages of hardness are illustrated by the record of the Monel rods in the pump shown above. The pump has been at work since 1918, handling gritty waters from ash quenching and corrosive waters from coal drainage. The Monel rods have given trouble-free service during the whole quarter-century.

A second pump was installed ten years after the first. Its rods were made of bronze. Three sets failed in less than 10 years. Monel rods were then installed. The second pump, like the first, has had no rod trouble since that time . . . the *hardness* of Monel along with its greater corrosion resistance, rigidity and toughness has made the difference.

Another application that shows how Monel's hardness cuts down trouble is the use of Monel steam separators for cargo vessels.

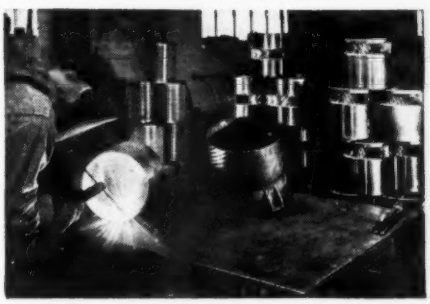


SUMP PUMP *with long-wearing hard Monel rods at work in New York Public Library for over 25 years.*

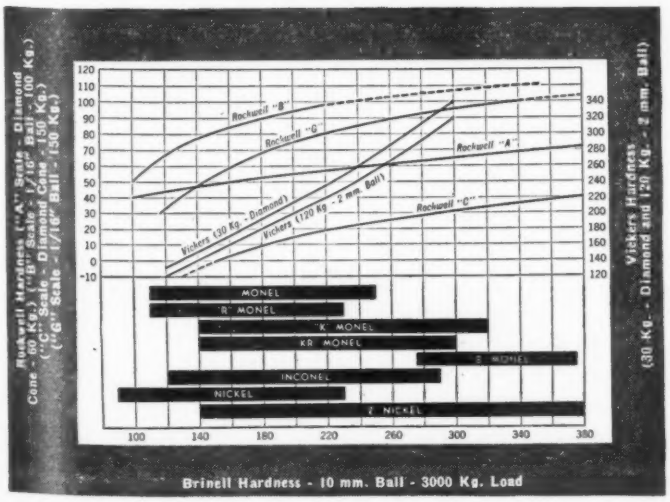
Steam coming direct from a boiler carries moisture and solid particles. This foreign matter would blow through the lines and erode the vital parts of equipment if the separator did not remove it.

Formerly, the Dri-Steam Products Co. used thick castings of a softer corrosion-resistant metal as inner cylinders for the separators. The cylinders often failed from erosion after only three months' service.

An improved type of separator was then fabricated from Monel sheet. Half the weight, and a third less expensive than the old type, the Monel separators have been in use for over two years. Not one has failed . . . Monel's added hardness has again produced longer, trouble-free life.



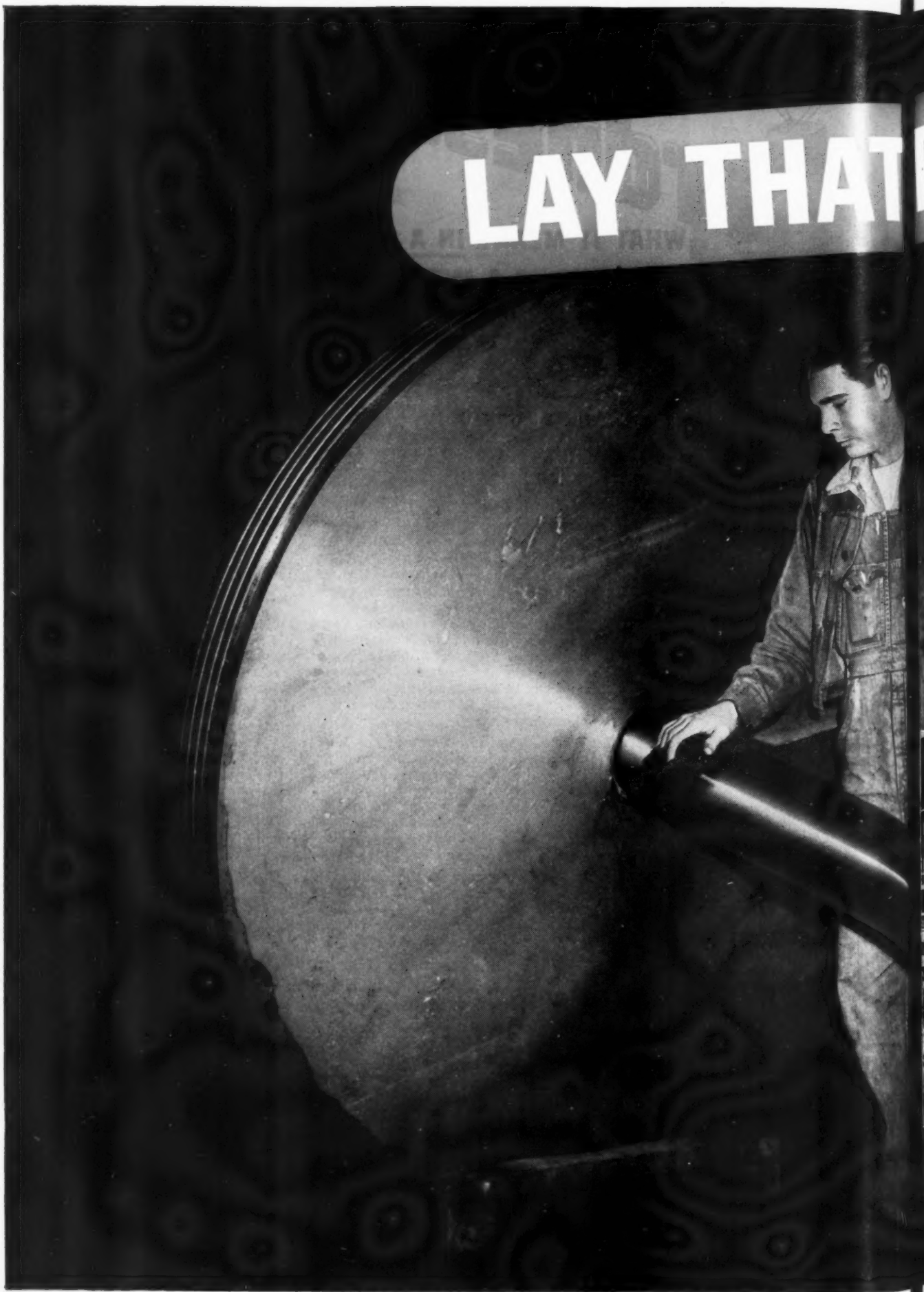
STEAM SEPARATORS *of hard Monel sheet, cut cost 30%, weight 50% . . . and give over 8 times the service of former type. Made by Dri-Steam Products Co., New York, N. Y.*


Rockwell Hardness ("A" Scale - Diamond Cone - 60 Kg.) ("B" Scale - 1/16" Ball - 100 Kg.) ("C" Scale - Diamond Cone - 150 Kg.) ("G" Scale - 1/16" Ball - 150 Kg.)
Vickers Hardness (30 Kg. - Diamond and 120 Kg. - 2 mm. Ball)
Rockwell "B"
Rockwell "G"
Rockwell "A"
Rockwell "C"
Vickers, 30 Kg. - Diamond
Vickers, 120 Kg. - 2 mm. Ball
MONEL
"R" MONEL
"K" MONEL
KR MONEL
"S" MONEL
INCONEL
NICKEL
"Z" NICKEL
Brinell Hardness - 10 mm. Ball - 3000 Kg. Load

HARDNESS OF INCO NICKEL ALLOYS. *The hardness range of each alloy is shown by the horizontal bars; the approximate relation between Brinell, Rockwell and Vickers hardness numbers is shown by the conversion chart.*

For further light on hardness . . . and on other mechanical properties that determine a metal's suitability for specific applications . . . write for a copy of the 26-page bulletin, "The Technical Editor speaks . . ." A copy is yours for the asking.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall St., New York 5, N.Y.



TUNE IN FRED ALLEN EVERY SUNDAY NIGHT—CBS

PISTON DOWN

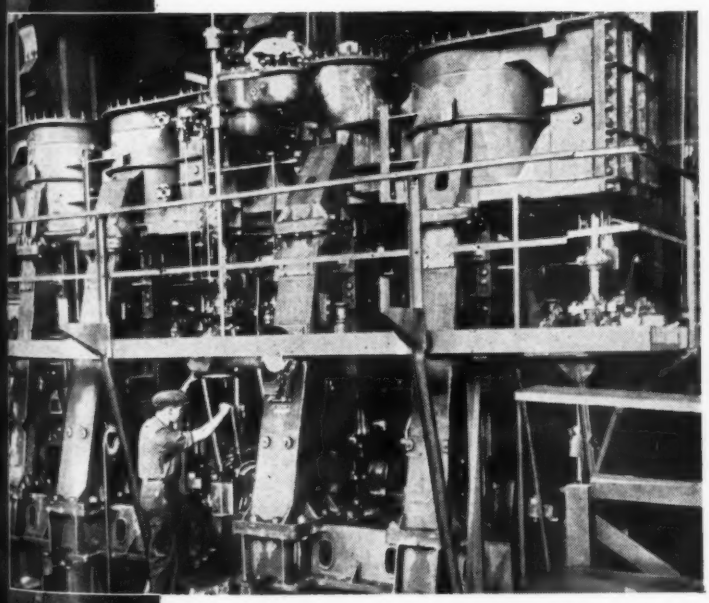
CALLED upon to break the motive power bottleneck of America's ship-building program, reciprocating steam engines have come into use in unprecedented numbers.

Similarly, the power shortage on land has been helped materially by hundreds of standby reciprocating units now back in active operation, many of which are efficiently lubricated with Texaco.

Whatever the steam temperature or pressure, in engines old or new, Texaco steam cylinder oils atomize completely, adhere to cylinder walls, separate rapidly from exhaust; assure quiet operation and low oil consumption.

So effective have Texaco lubricants proved that they are definitely preferred in many fields, a few of which are listed below.

Texaco Lubrication Engineering Service is available to you through more than 2300 Texaco distributing points in the 48 States. The Texaco Company, 135 East 42nd Street, New York 17, N. Y.



THEY PREFER TEXACO

★ *More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.*

★ *More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.*

★ *More locomotives and railroad cars in the U. S. are lubricated with Texaco than with any other brand.*

★ *More revenue airline miles in the U. S. are flown with Texaco than with any other brand.*

★ *More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.*

TEXACO

REG T M

TEXACO Steam Cylinder Oils

FOR EVERY STEAM CONDITION

HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY

"IN 6 MONTHS THIS VOLTAGE REGULATOR PAID FOR ITSELF TWICE OVER IN SAVINGS IN PAPER AND MAN-HOURS"

. . . reports blueprint-machine user

3.6-kva, automatic, induction voltage regulator (Control panel is mounted separately.)

PROBLEM A large Midwestern plant was experiencing considerable trouble in its blueprinting department because of fluctuating voltage. This poor voltage condition was caused by a varying power and lighting load. The high-intensity, mercury-vapor lamps being used in blueprinting were burning out needlessly. Large quantities of blueprint paper were being wasted because it was necessary to make trial prints at various times of the day to determine proper exposure. There was also a waste when making microfilm records of large-size prints, because varying voltage caused a varying intensity of light and, hence, underexposure or overexposure.

SOLUTION No *special* equipment was needed to lick the problem. General Electric engineers suggested two 3.6-kva, 240-volt, automatic, dry-type, induction voltage regulators, selected from our standard AIRS line.

RESULTS Now, after less than six months, the manufacturer reports that these *automatic* regulators have already paid for themselves at least twice—in materials plus man-hours saved. Under the old setup, it was necessary to adjust the voltage by hand several times a day.

WHAT'S YOUR PROBLEM? Pepless motors, poor lighting, uncertain test results, and production slumps are often the result of poor voltage. Whether you need voltage control for a vacuum tube or a power shovel, there's a simple, economical G-E device for the job. *General Electric Company, Schenectady 5, N. Y.*

OTHER G-E AIDS TO BETTER VOLTAGE

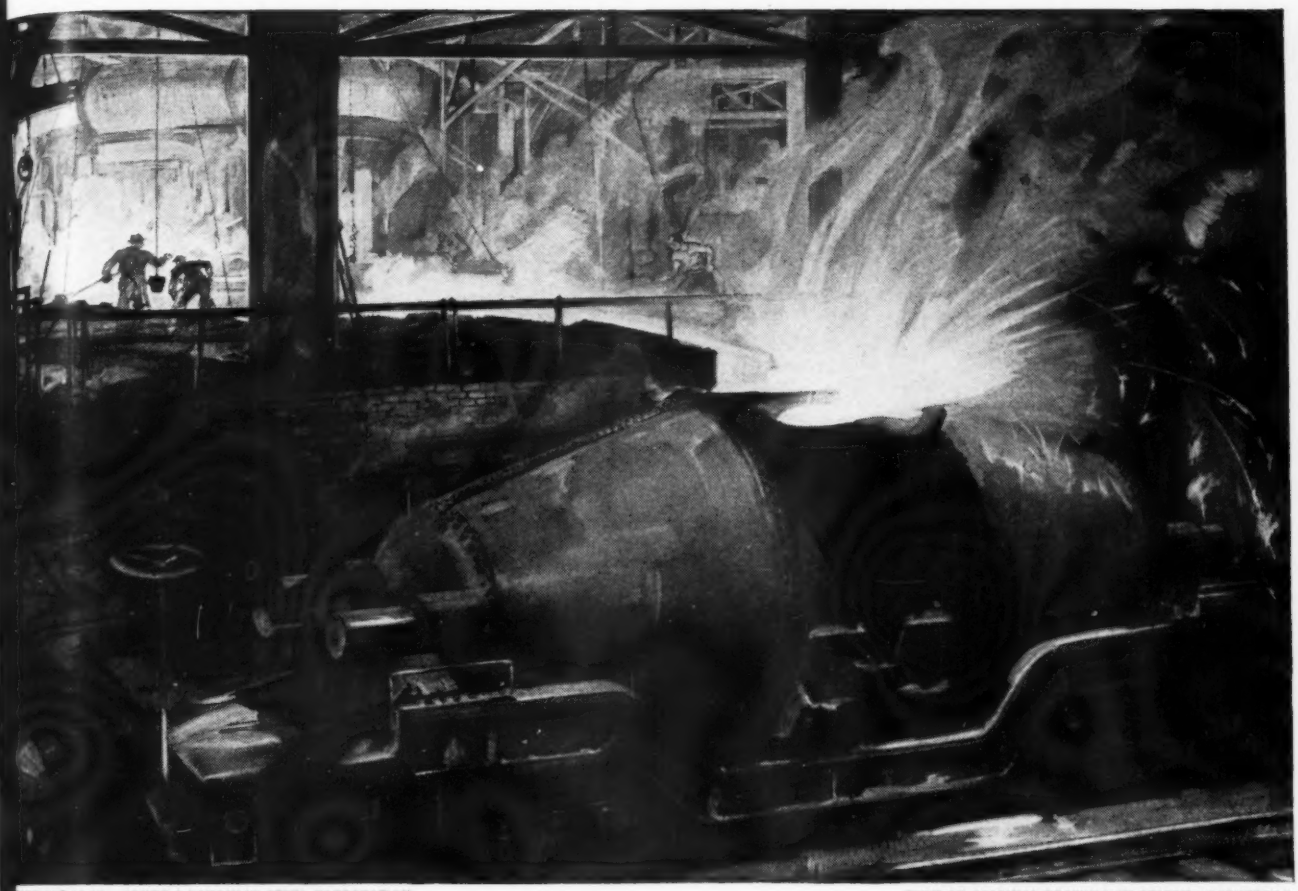
VOLTAGE STABILIZER—Automatically provides a constant 115-volt supply to a given load, on circuits varying from 95 to 130 volts. Ratings from 50 to 5000 va. Ideal for precision laboratory or manufacturing processes, or built into such equipment as radio transmitters. VARIABLE-VOLTAGE AUTO-TRANSFORMER—Provides smooth, adjustable control of voltage, current, light, temperature, power, and speed at a turn of the dial. Ratings from 243 to 810 va. Ideal for use in factories, laboratories, and assembled with other equipment. TYPE D TRANSFORMER—For insulating lighting circuits, reducing light flicker, boosting or stepping down voltage for the most economical operation of motors, welding equipment, etc. Ratings up to 100 kva, 600 volts.

THE RIGHT VOLTAGE AT THE RIGHT PLACE DOES THE JOB **BETTER**

BUY WAR BONDS

GENERAL ELECTRIC

403-64-5205
5400



COPYRIGHT 1944 — JONES & LAUGHLIN STEEL CORPORATION

FROM AN ORIGINAL DRAWING BY ORISON MACPHERSON

MOUNTAINS SMELTED TO GET IRON FOR STEEL

Mountains of iron ore, coke and limestone are charged every year into America's blast furnaces. The ore is smelted into iron by volcanic fires fanned by tornadic blasts of millions of tons of super-heated air. The molten iron streams out of the towering stacks day and night, week in and week out, to be converted into steel — in 1943, for war, the greatest tonnage of steel ever produced in this country. Blast furnace men, steel men and metallurgists, through long experience and continuous research, are building into iron that better quality essential to production of the new steels now hastening victory — the versatile steels that will serve peace-time needs as soon as the war is won.

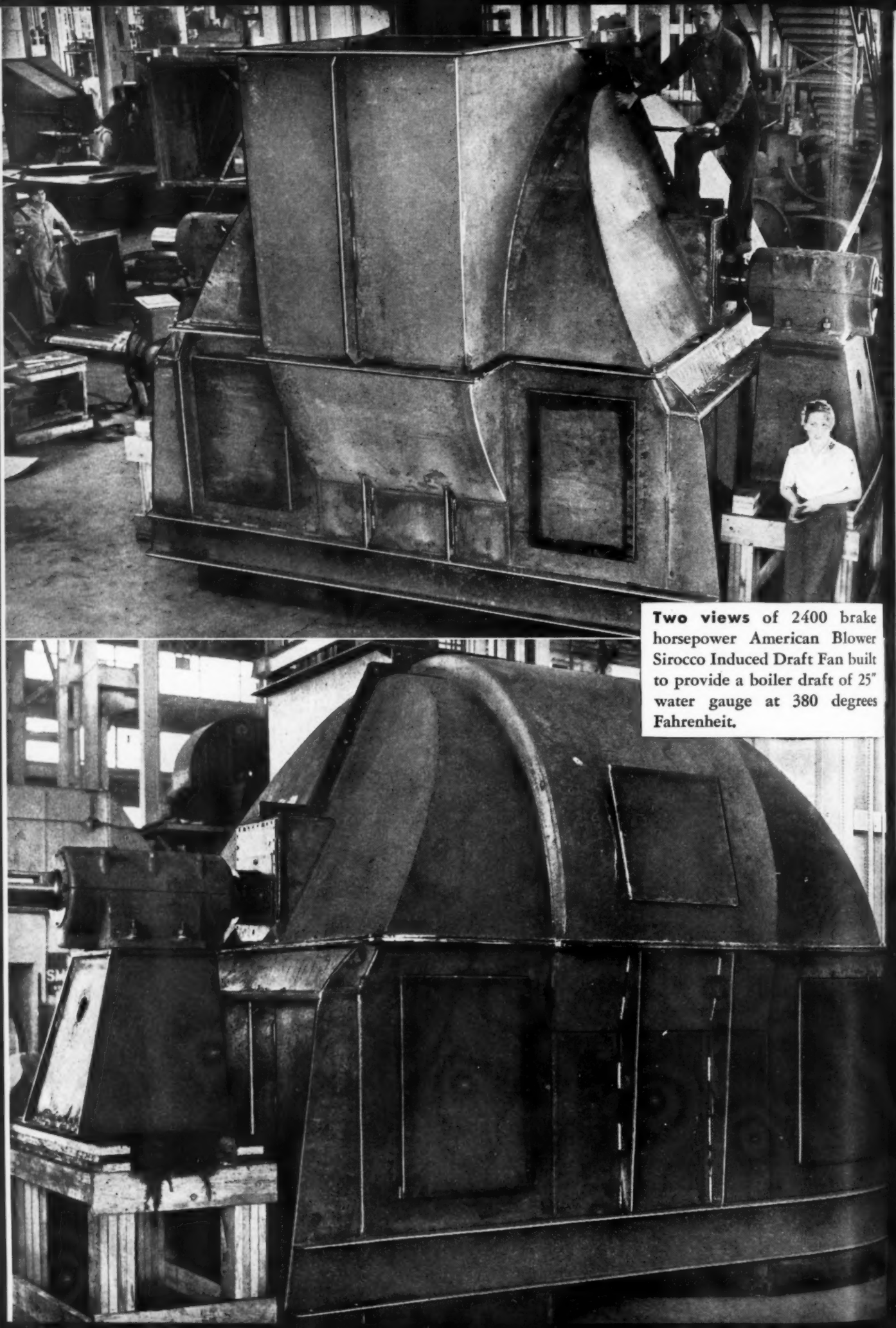
JONES & LAUGHLIN STEEL CORPORATION

PITTSBURGH, PENNSYLVANIA

CONTROLLED QUALITY STEEL FOR WAR

J&L STEEL

J&L STEEL



Two views of 2400 brake horsepower American Blower Sirocco Induced Draft Fan built to provide a boiler draft of 25" water gauge at 380 degrees Fahrenheit.

Progress and Power in

PUBLIC UTILITIES

The Wheel of an American Blower Sirocco Induced Draft Fan. Fans of this type are functioning in many of the nation's largest power plants and in industry.

Unprecedented demand for vital electric energy has placed upon the public utilities of America the greatest load in their history. Working day and night to the limit of their capacity, they are providing continuously over 50,000,000 kilowatts of dependable electric power to the industries, military centers, transit lines and homes of the nation.

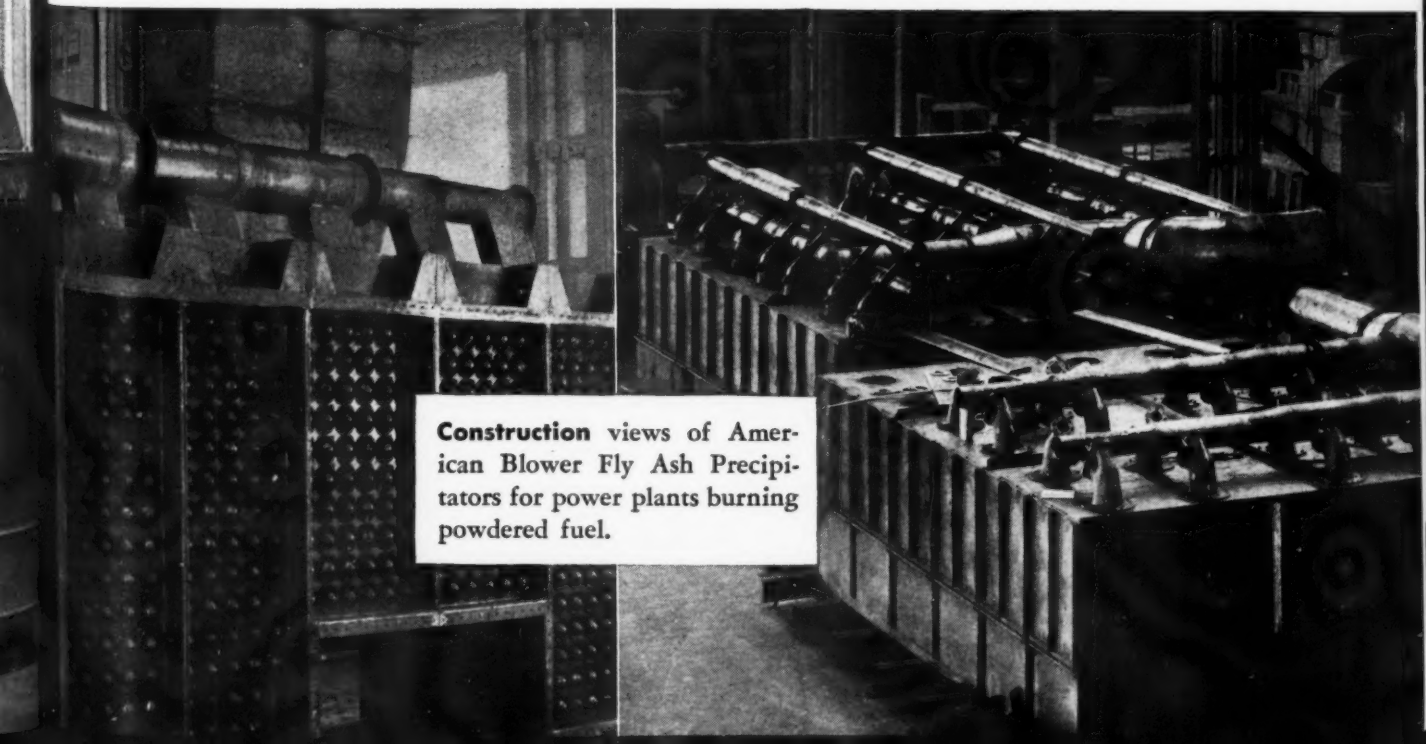
Working shoulder to shoulder with the public utilities to provide this mighty output is modern equipment developed and built by American Blower — forced and induced draft fans, blowers, fly ash precipitators and fluid drives (hydraulic couplings) for variable speed control of fans and pumps.

When new installations or replacements in power plants are contemplated, consult American Blower, makers of mechanical draft and other equipment for air handling since 1881.

ARMY E NAVY
For Production "Well Done"

AMERICAN BLOWER

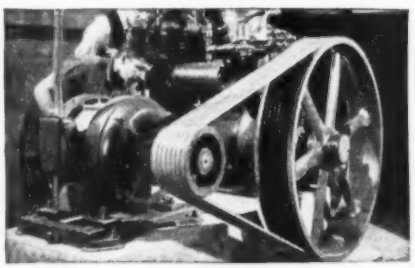
AMERICAN BLOWER CORPORATION, DETROIT, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation



Construction views of American Blower Fly Ash Precipitators for power plants burning powdered fuel.

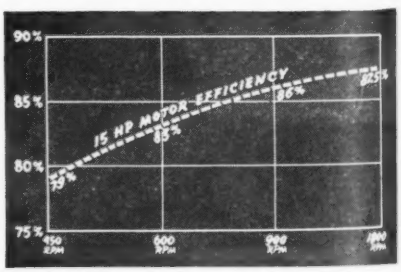
A-C "Team" Flexibility

★ To drive low speed machinery with high speed motors (now that low speed motors are sharply restricted), Allis-Chalmers Texrope Drives can "gear down" motor speeds over a range of 7 to 1. As America's only builder of *both* motors and V-belt drives, Allis-Chalmers has long studied and advocated their use in proper com-



1 In most applications, an 1800 rpm motor with Texrope Drive will ably do the job of a lower-speed, direct-connected motor —at lower cost in money *and materials!*

2 When you buy an 1800 rpm instead of 450 rpm 15 hp squirrel-cage motor, for example, 600 lb are saved. And *you* save well over $200 — with drive figured in!



3 Note that efficiency rises from 79% for the 450 rpm motor to 87.5% for the 1800 rpm motor. The 1800 rpm motor saves you over 30 kw/24 hr. day.

WE WORK FOR VICTORY WE PLAN FOR PEACE

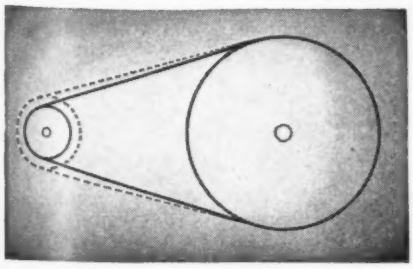
ALLIS-C

Gives You now needed

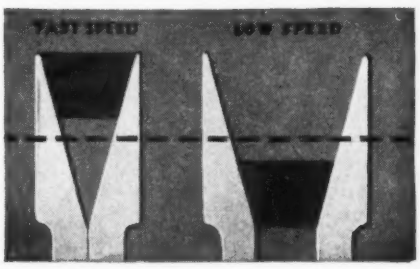
bination . . . today offers you the benefit of long pioneering experience. Texrope Drives are compact, highly efficient, protect your equipment by absorbing shock.

★ To drive a machine at different rates with a single speed motor (now that multi-speed motors are sharply restricted), Texrope Adjustable-Speed Drives give you infinite speed range up to 375%. And in Allis-Chalmers full line of Texrope Drive equipment you'll find the *right* range for your machines . . . thus avoid paying extra for more speed than you need. For engineering cooperation, feel free to call on your nearby Allis-Chalmers district office or write to Allis-Chalmers, Milwaukee 1, Wisconsin.

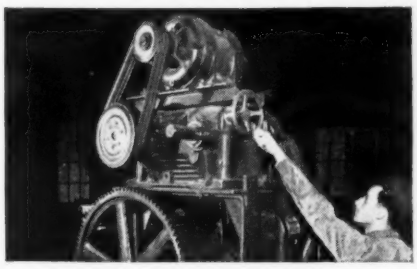
A 1706



4 Infrequently needed speed changes can be had by changing from one size motor sheave to another. Juggling *complete* drives, range is 1:1 to 7:1.



5 With the Allis-Chalmers Vari-Pitch Sheave, you can increase or decrease speed by adjusting sheave diameter . . . obtaining an *unbroken* series of speeds!



6 Allis-Chalmers Vari-Pitch Speed Changer gives you infinite changes at the turn of a wheel — within 3.75 to 1. It's compact, flexible, *efficient!*

A-CHALMERS

LO-MAINTENANCE MOTORS
TEXROPE DRIVES

LUNKENHE

whateve

Fig. 1640
"King-clip" Gate

Fig. 16
"Renewo" Globe

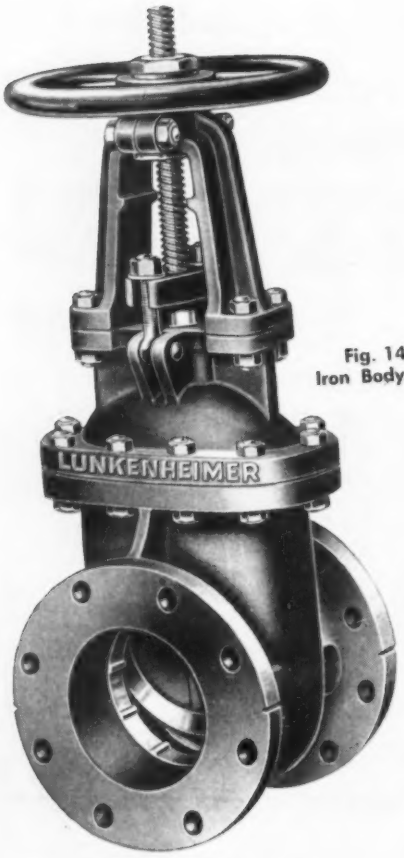


Fig. 1430
Iron Body Gate

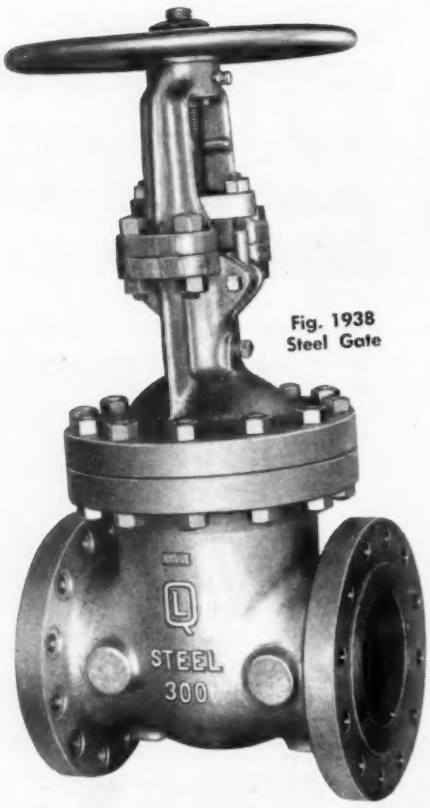


Fig. 1938
Steel Gate

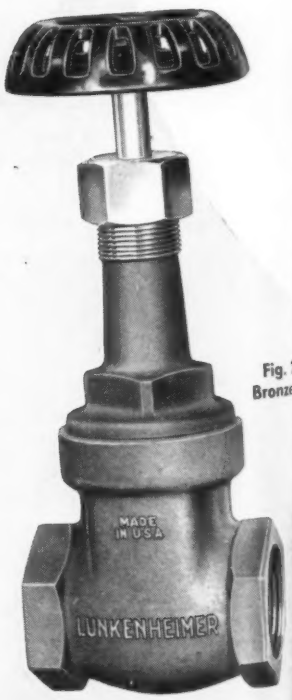


Fig. 2
Bronze

SIMPLICITY OF DESIGN MEANS EASIER MAINTENANCE

ER VALVES

ype.. mean better service

In the heavy duty that Lunkenheimer Valves are doing on every front—industrial, maritime, army and navy, chemical, petroleum, synthetic rubber—a prime attribute is *lasting* quality . . . that inherent quality that comes of correct engineering, simplicity of design, and "know-how" manufacturing born of long experience.

These features in Lunkenheimer Valves are proving a boon to maintenance crews, in uninterrupted performance, low maintenance expense, and ease in making repairs . . . in short, better service.

Let your Lunkenheimer distributor help you with your maintenance, repair and operating problems. His facilities and experience are at your call.

Lunkenheimer Catalog 78 available on request.

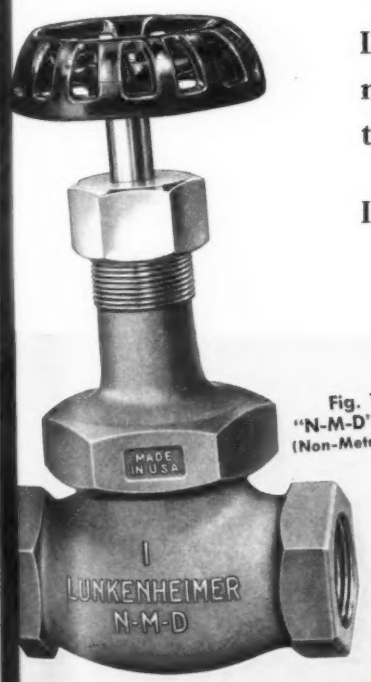


Fig. 123
"N-M-D" Globe
(Non-Metallic Disc)

ESTABLISHED 1862

THE LUNKENHEIMER CO.

"QUALITY"

CINCINNATI 14, OHIO. U. S. A.

NEW YORK 13 CHICAGO 6
BOSTON 10 PHILADELPHIA 7

EXPORT DEPT. 318-322 HUDSON ST., NEW YORK 13, N. Y.

IONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S.P.; BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS

28-113-43

Why successful

What goes on inside many of America's boilers is revealed to Hall chemists through these samples of boiler water. Careful periodic analyses by Hall Laboratories, in conjunction with simplified control analyses made regularly by the plant personnel, assure the proper water treatment to keep these plants in continuous operation year after year.

boiler operation is an *"inside job!"*

PROGRESS began in water conditioning service when a group of Hall chemists started the research into what goes on *inside* a boiler. At that time power plant operators were at the mercy of scale, corrosion, carryover and embrittlement.

To this simple, and now clearly obvious approach to the problems of boiler water conditioning, which Hall Laboratories follow as vigorously today as they did twenty years ago, the entire steam power world is indebted. One by one the mysteries surrounding the effects of steam under high pressures and high temperatures have been solved. On learning the causes the road was cleared for finding the remedies.

Out of this knowledge and experience has come the best system ever devised for keeping a boiler out of trouble arising from water—THE HALL SYSTEM OF PREVENTIVE CARE. Operated within your own plant, by your own personnel under direct Hall field supervision, it effectively eliminates unscheduled outages which owe their origin to scale, corrosion, embrittlement and carryover.

Today, in many of the country's leading power plants, Hall preventive care is as much a part of their operating system as the very boilers in which it is employed. The reason is plain. It brings results. They have the comforting assurance that behind it is the world's most authoritative source for the solution of water conditioning problems.

You can probably remember the time when the only clean boiler was a new one. Today, through Hall preventive care, countless veteran boilers are contributing mightily to war production. May we give you further facts about this service?

HALL LABORATORIES, INC., Hagan Building, Pittsburgh 30, Pa.
A Subsidiary of Hagan Corporation

Water samples are accurately checked to see that oil content is being kept to an absolute minimum.

HAGAN HALL BUROMIN CALGON

HALL SYSTEM *of Boiler Water Conditioning*

Hall Service in a Nutshell

At your immediate disposal are placed the technical knowledge and facilities of the pioneering leaders in scientific boiler water conditioning. In addition, with your full cooperation, Hall Service:

1. **Minimizes boiler outages caused by water.**
2. **Helps maintain highest efficiency.**
3. **Establishes non-embrittling water**
4. **Minimizes carryover.**
5. **Prevents corrosion in boilers and associated equipment.**
6. **Prevents deposition in water lines and cooling systems.**

★ ★ ★ **A New Pneumatic T**

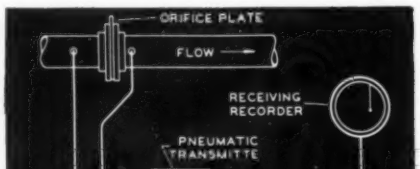
FOR MEASURING FLOW AND LEVEL

Operating on the Force-Balance Principle

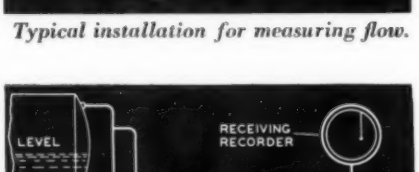
The Republic Differential Pressure Transmitter is an entirely new type of pneumatic meter which has been thoroughly field tested during the past two years. It is a simple pneumatic device for converting a differential pressure, such as is produced by the flow of a fluid through an orifice or by liquid level in a vessel, into an air pressure which varies proportionately with the differential pressure.

This air pressure is used as a direct measure of the differential pressure and can be conducted to a remote location by means of tubing. A gage or receiver connected anywhere in this transmission line will show the variations in the differential pressure and may be graduated in terms of the flow or level which it represents. The pressure can also be utilized as the impulse for actuating a controller.

The Republic Pneumatic Transmitter operates exactly like a weigh scale. The force of the differential pressure on a measuring diaphragm is the value being weighed. This force, multiplied by its lever length, is balanced by the force on a reaction diaphragm times its lever length. The pressure on the reaction diaphragm represents the weights used on a scale and is merely a means of automatically accomplishing this weighing process and transmitting the results.



Typical installation for measuring flow.



Typical installation for measuring liquid level.

RANGES—standard ranges are available from 0.9 in. to 25 in. of water differential, for working pressures up to 15 psi.; 7 in. to 50 in. of water for working pressures up to 25 psi.; and 13 in. to 800 in. of water for working pressures up to 600 psi. Special heads can be provided for working pressures up to 2000 psi.

RANGE EASILY CHANGED—the range of a Republic transmitter can be readily changed by making a few minor adjustments or substituting a few simple parts. For example, a transmitter with a differential range of 50 in. of water can be changed to any range up to 100 in. of water by merely changing the position of the reaction diaphragm.

DIAPHRAGM MATERIAL—diaphragms for the Republic transmitter can be made from practically any material including rubber, synthetic rubber, Saran, brass, stainless steel, Monel, silver, etc. This is possible due to the extremely small motion required. (.010 in. for full scale reading). The material is specified in accordance with the solvent or corrosive action of the measured fluid.

●

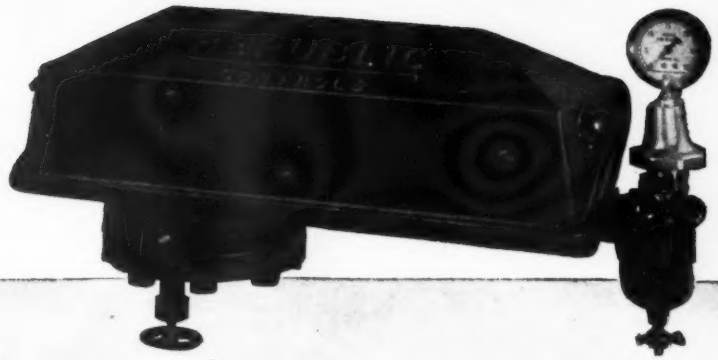
For complete details write for Bulletin No. 43-4

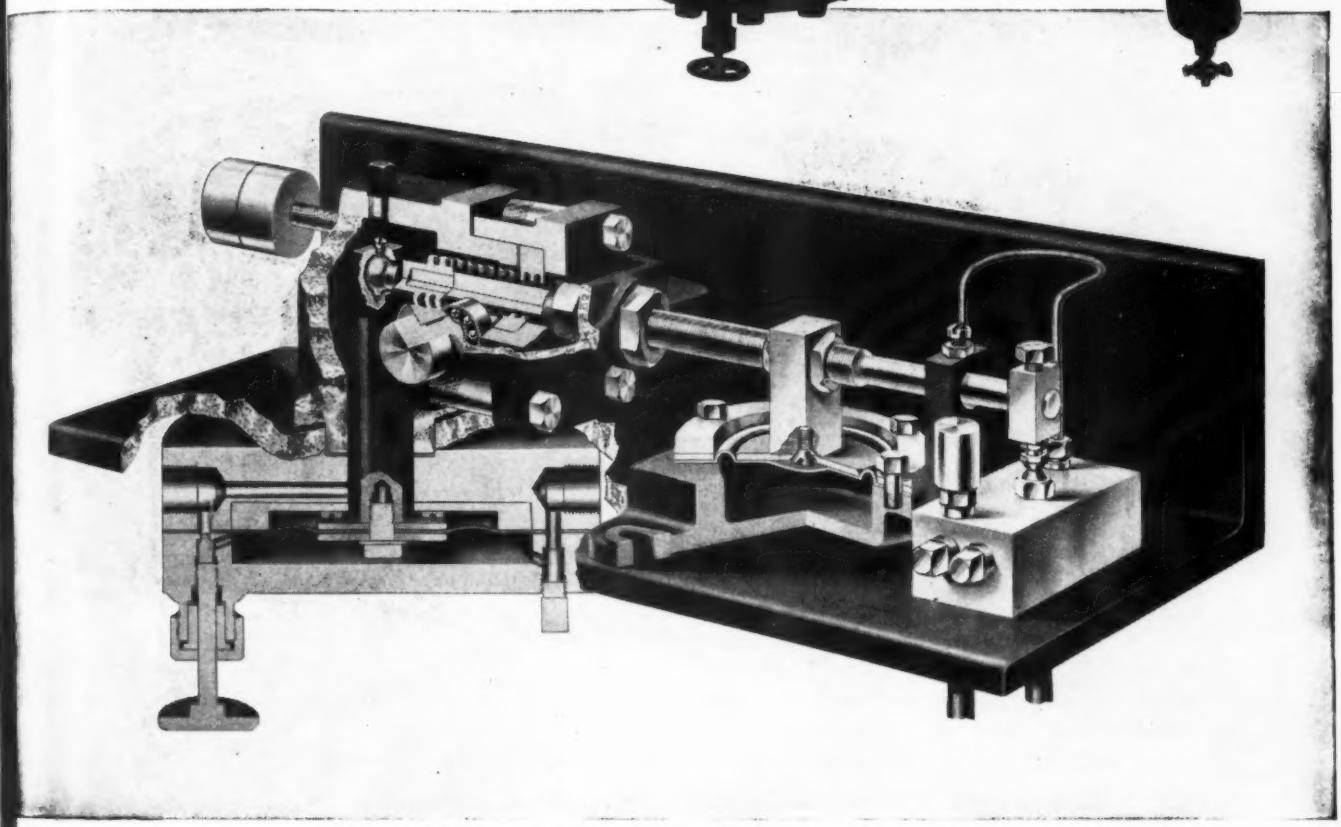
REPUBLIC INSTRUMENTS AND CONTROLS

REPUBLIC

2222 DIVERSEY

Transmitter





Exterior and cut-away view of the Republic Pneumatic Transmitter.

PERFORMANCE FEATURES

ACCURACY of the Republic force-balance method of measurement is higher than can be consistently secured and maintained with any other method. Transmitting pressure vs measured differential is guaranteed within ½ of 1% of meter range.

SENSITIVITY — due to the negligible motions required for complete operation of all parts for full scale change, no appreciable hysteresis results from reversal of direction of measurement change. The hysteresis loop is so small that it is undetectable by ordinary means, being less than 1/20 of 1%.

RESPONSIVENESS — due to the fact that there is virtually no volume displacement, the Republic Pneumatic Transmitter is able to follow flow changes almost instantaneously. The time required to produce full output pressure at the transmitter is in the nature of fractions of a second, after the differential is imposed. Therefore a receiving instrument installed adjacent to the transmitter will show flow changes almost instantly. With 500 feet of ¼ in. O. D. tubing, the full value of the change will have registered on a Republic receiver in 15 seconds. This is the overall lag in the system not merely the transmission lag.

NO TEMPERATURE EFFECT — the effect of ambient temperature variations on the accuracy of a Republic transmitter is negligible. Since all parts are equally affected by temperature changes, force and leverage relationships are not disturbed and accuracy is unimpaired.

NO VIBRATION EFFECT — the Republic transmitter is unaffected by any normal frequency of vibration ordinarily encountered in industrial or process plants.

AIR CONSUMPTION — the air consumption of the pneumatic system is .20 cfm. maximum at 20 psi. supply pressure, when differential is zero. At maximum differential consumption is zero and is inversely proportionate to intermediate, differentials.

FLOW METERS CO.

PARKWAY • CHICAGO • ILLINOIS

Tomorrow's boiler water level supervision is ready for you Today

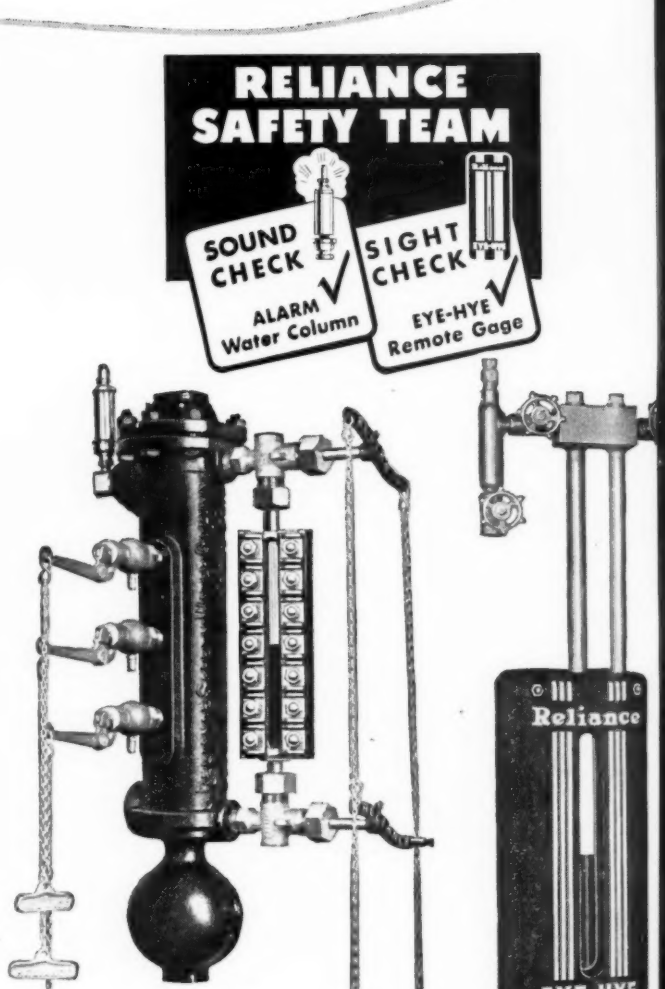
...You can plan now, safely, for better boiler protection that's ready for you in the proved Reliance Safety Team

Whatever improvements you plan in your power plant — for more efficient production, more capacity, lower operating cost — you're more than likely to include *modern water level indication.* It's in the cards. And experience points to *double protection* as the safest, most economical aid to water level supervision.

The Reliance Safety Team — the trouble-proof Reliance ALARM Water Column and the EYE-HYE Remote Reading Indicator — stands ready to do a thorough job for you. The ALARM is your mechanical guardian — loudly warning of dangerous water levels if they develop. EYE-HYE brings the true water level down to eye level, a convenient sight check that enables operators on the floor to prevent troublesome situations.

War restrictions have prevented photography that would illustrate hundreds of installations similar to the examples shown. We'll be glad to tell you about them — cases that represent widely varying conditions and any working steam pressure you could name.

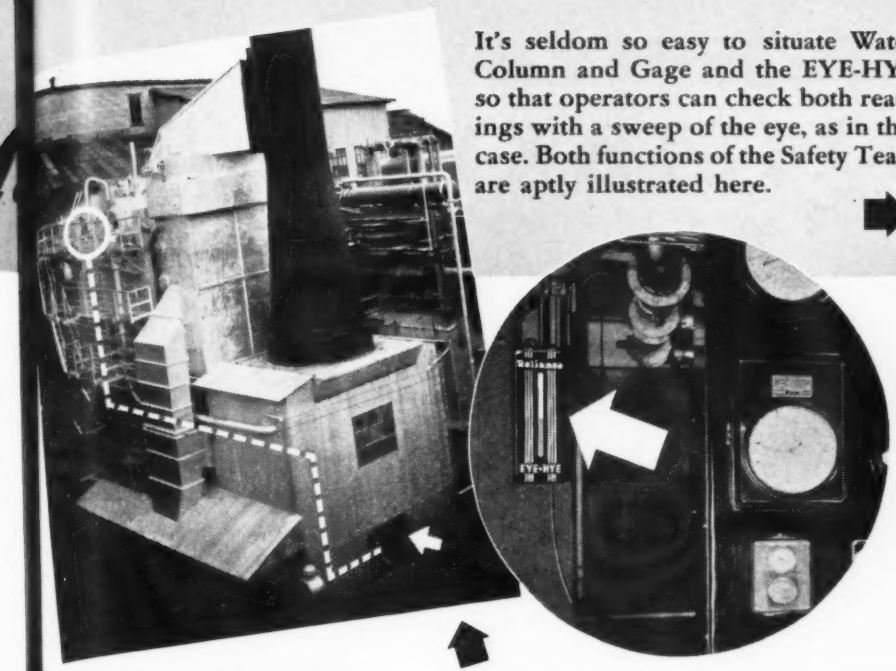
Write for more information.



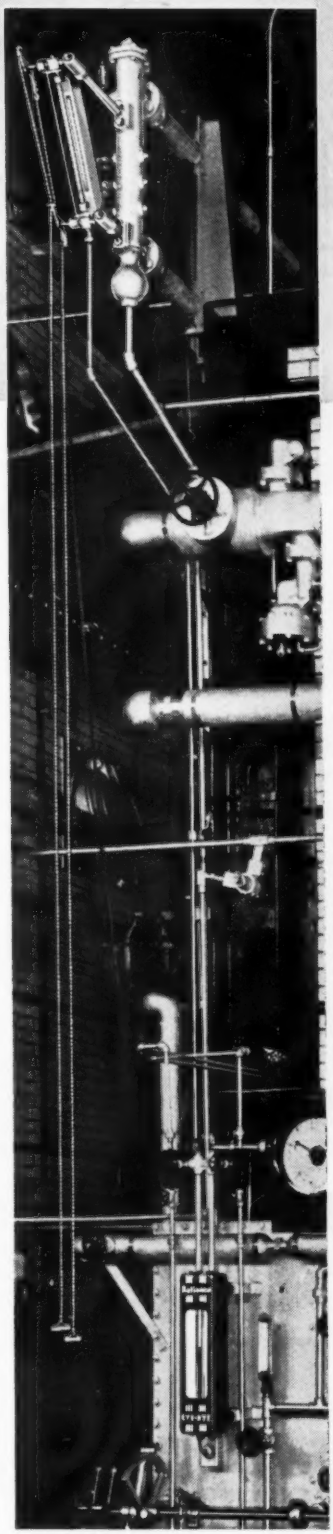
60 Years of Boiler Protection

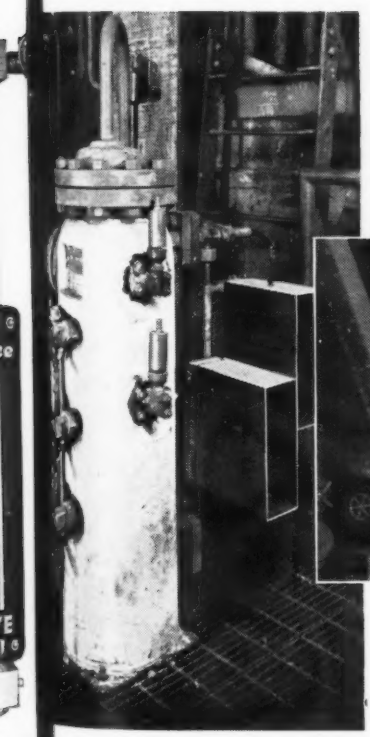
1884-1944 Reliance

few of the many cases where Reliance Safety am applications smooth the supervision job

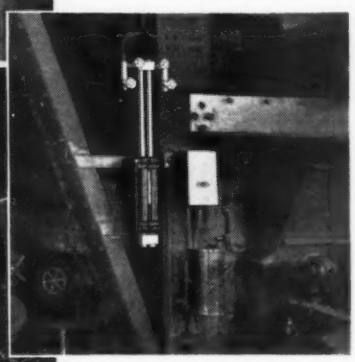


It's seldom so easy to situate Water Column and Gage and the EYE-HYE so that operators can check both readings with a sweep of the eye, as in this case. Both functions of the Safety Team are aptly illustrated here.





Just the opposite — an unusually difficult situation is brought to you in these two photographs. A southern "exposed" plant with water column high up out-of-doors is an ideal case for the Remote Reading member of the team — the EYE-HYE. Whatever the weather, power engineers get a trustworthy water level reading without leaving the front of the panel board.



Even where you have a gallery for safe perch when checking the water gage, you can't always be *up*. And it doesn't take long for trouble to develop. You feel unusually secure when you know the EYE-HYE is a few steps away on ground level. Both devices do an excellent job of team work.

SEND US a rough diagram of your present power plant or the one you plan to build. Or describe your water level supervision problems. It will pay you to be ready for action when you can make the changes you need.

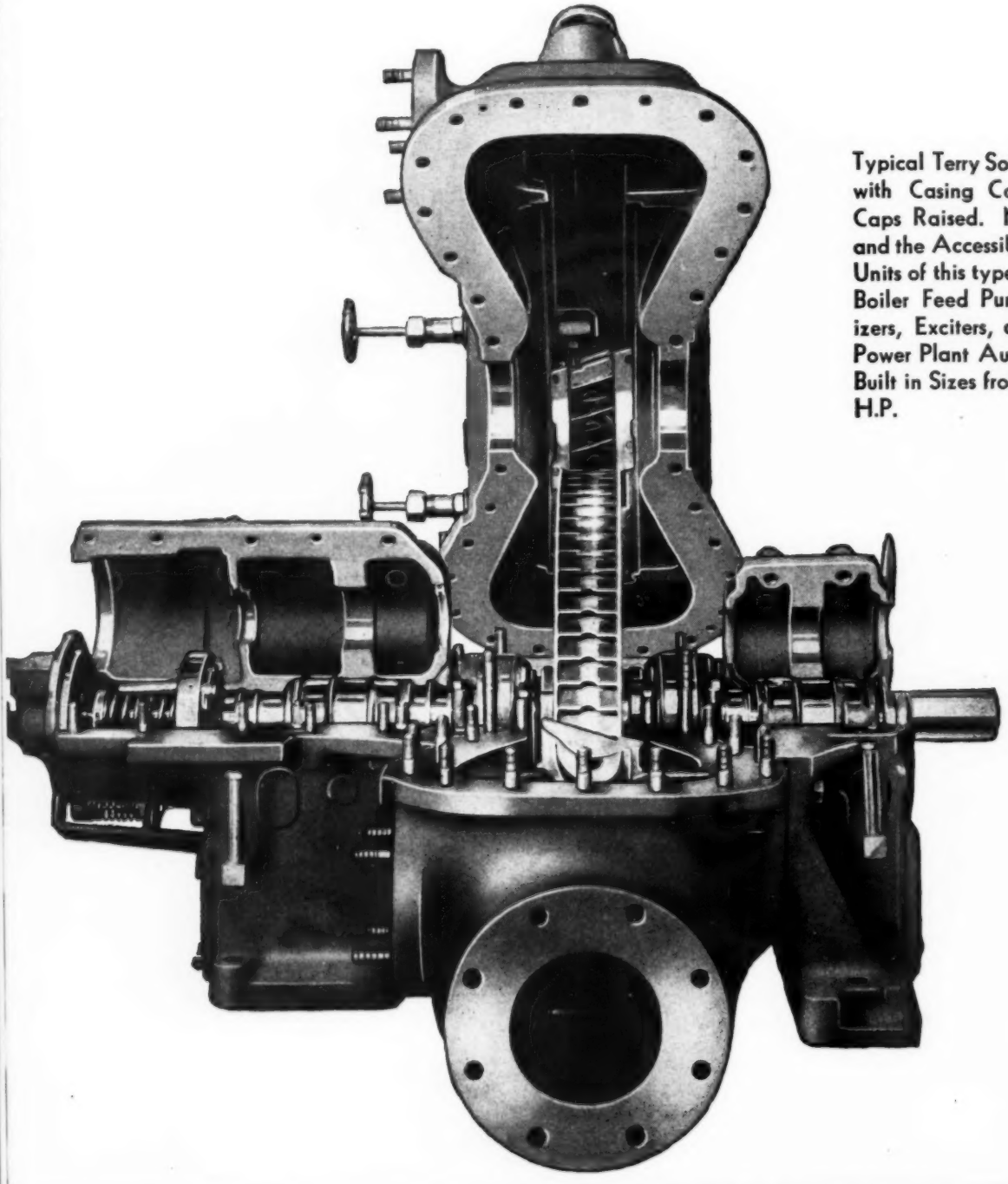
OILER SAFETY DEVICES

THE RELIANCE GAUGE COLUMN CO.
Cleveland, Ohio

Buy More War Bonds

The TERRY

FOR AUXILIARY DRIVE



Typical Terry Solid Wheel Turbine with Casing Cover and Bearing Caps Raised. Note Ruggedness and the Accessibility of All Parts. Units of this type are used to drive Boiler Feed Pumps, Coal Pulverizers, Exciters, and All Types of Power Plant Auxiliary Equipment Built in Sizes from 5 H.P. to 2000 H.P.

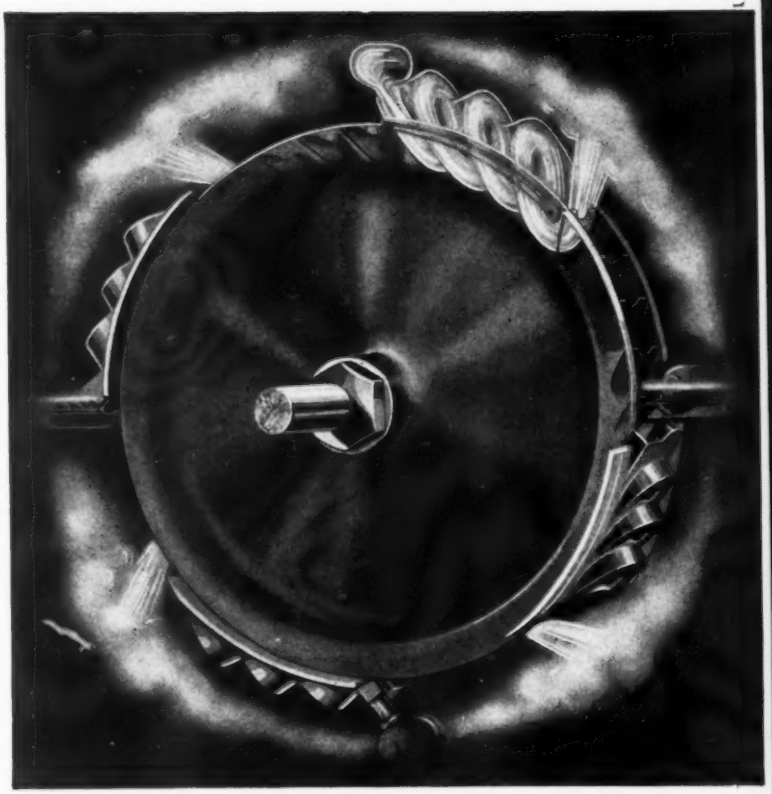
THE TERRY STEAM TURBINE CO.

Wheel Turbine

OFFERS MANY ADVANTAGES

FROM THE SMALLEST TO THE LARGEST, THESE RELIABLE TURBINES HAVE —

- Indestructible One Piece Wheel
- Large Radial and Axial Clearances
- Double Rim Protected Blading
- Dependable and Durable Governor
- Heavy Dust-Proof Bearing and Governor Housing
- Independent Overspeed Trip with Separate Valve
- Sturdy Casing Design
- Strong and Easily Inspected Steam Strainer
- Sight Oil Level Gauges
- Individual Nozzle Control
- Truly Accessible Construction, Which Makes Inspection of the Interior Parts a Simple Matter



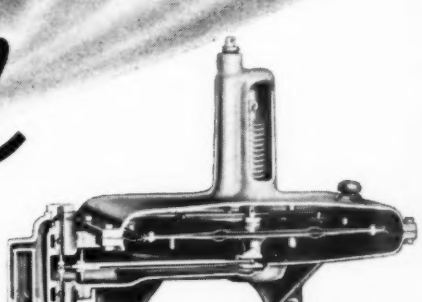
Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

For Full Details ask for Bulletin S-116

TERRY SQUARE - HARTFORD, CONN.

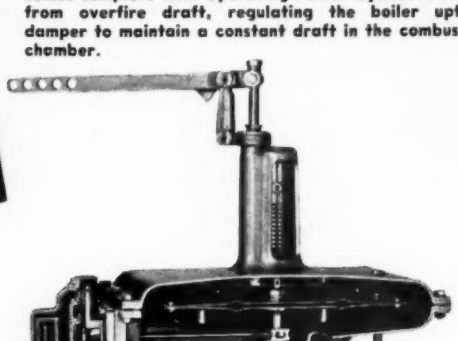
To maintain a FUEL SAVING PROGRAM and easily produce sufficient Steam

INSTALL CASH STANDARD AUTOMATIC COMBUSTION CONTROL SYSTEMS



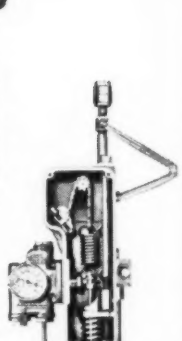
FURNACE DRAFT CONTROLLER

This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper to maintain a constant draft in the combustion chamber.



AIR FLOW CONTROLLER

This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.



FUEL FEED CONTROLLER

This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

★ Your same boiler, equipped with this system, will use less coal, oil, or gas and you boost boiler output. You get more and yet cut costs. That's the beauty of equipping your boiler room with CASH STANDARD Automatic Combustion Control—simple to do—and it's greater economy all the way with more steam from less fuel. You really do have a fuel-saving program — and your boiler requires much less attendance time.

The three units shown here do the job — together they give you Correct Fuel Feed (no waste)—Proper Air Supply (fuel savings) and Constant Over-Fire Draft (undue stack loss prevented).

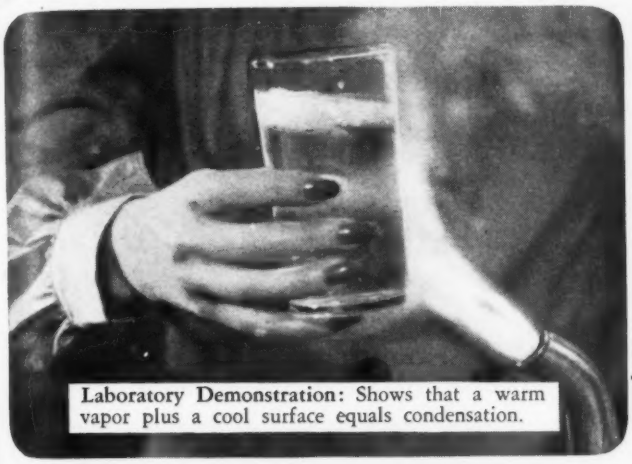
There are numerous variations of each unit—combinations are easily arranged to best serve you.

Write today for Bulletin No. 300.

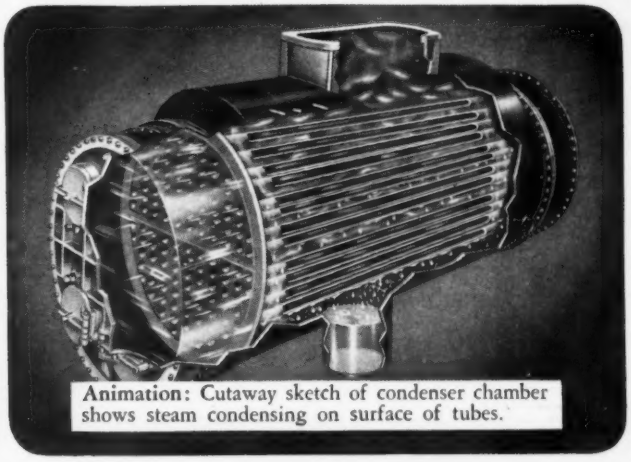
A. W. CASH COMPANY
DECATUR, ILLINOIS

CASH STANDARD CONTROLS . . VALVES

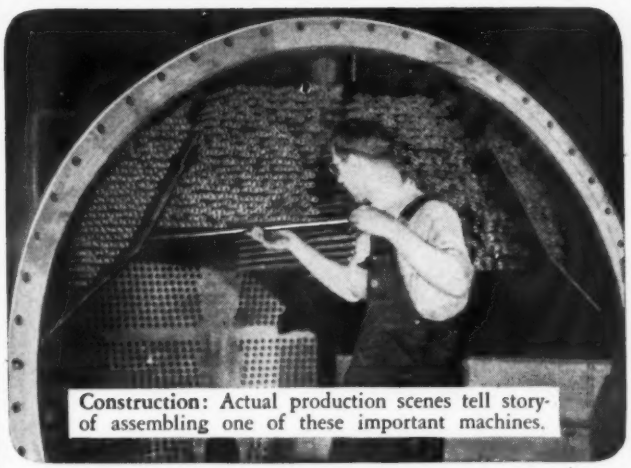
NEW MOVIE SHOWS WHAT HAPPENS
INSIDE A SURFACE CONDENSER



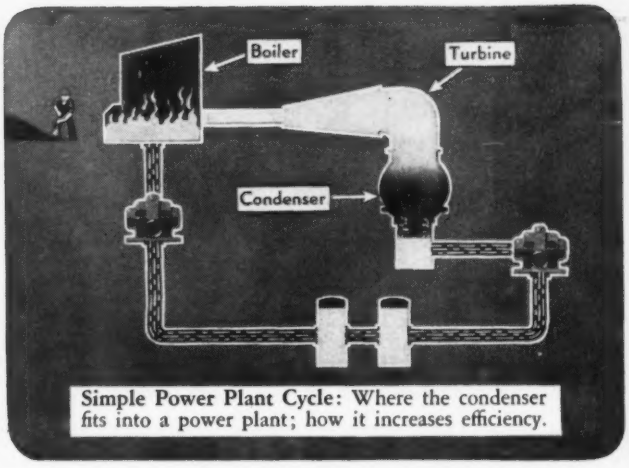
Laboratory Demonstration: Shows that a warm vapor plus a cool surface equals condensation.



Animation: Cutaway sketch of condenser chamber shows steam condensing on surface of tubes.



Construction: Actual production scenes tell story of assembling one of these important machines.



Simple Power Plant Cycle: Where the condenser fits into a power plant; how it increases efficiency.

NOW for the first time — you can study the interior of this important machine in Allis-Chalmers' new movie, "The Surface Condenser."

BECAUSE POWER PLANTS today lean heavily on Surface Condensers for new high efficiencies ... Because engineers, students, men in government, industry and the armed services can use more information about Surface Condenser operation and construction — Allis-Chalmers offers you a new sound motion picture, "The Surface Condenser."

Using animation and shop photography, this film demonstrates the "condensation" theory, shows how a condenser is built, how it operates in the power plant cycle.

Contains no advertising. 16 millimeter prints are available to all for free loan or purchase. Running time is 18 minutes, and the film can be used on sound projectors *only*. To obtain your print, just fill in and mail the coupon at right.

If you want to keep "The Surface Condenser" as a permanent addition to your film library, you can buy a print at cost for $24.

Note: This film when used in conjunction with Allis-Chalmers Steam Turbine movie, "The Magic of Steam", gives you a full 40-minute program on turbines and condensers. If you wish to show them together, ask for both films when filling out coupon at right. A 1697

ALLIS-CHALMERS MFG. CO.
Milwaukee 1, Wisconsin

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Gentlemen:

☐ I would like to borrow one 16 mm. print of your new sound movie, "The Surface Condenser" for showing before

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☐ Lend me also a print of your Steam Turbine Movie, "The Magic of Steam".

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POWELL is always ready and willing to give you advice on the care and maintenance of your valves. But valve failures are not always due to lack of knowledge—or neglect.

In countless instances valves fail to perform as they should because they're not of correct design and material for the services in which they are installed.

By consulting **POWELL** Engineering *first* you can avoid these failures because *Powell performance is pre-determined*—by experts.

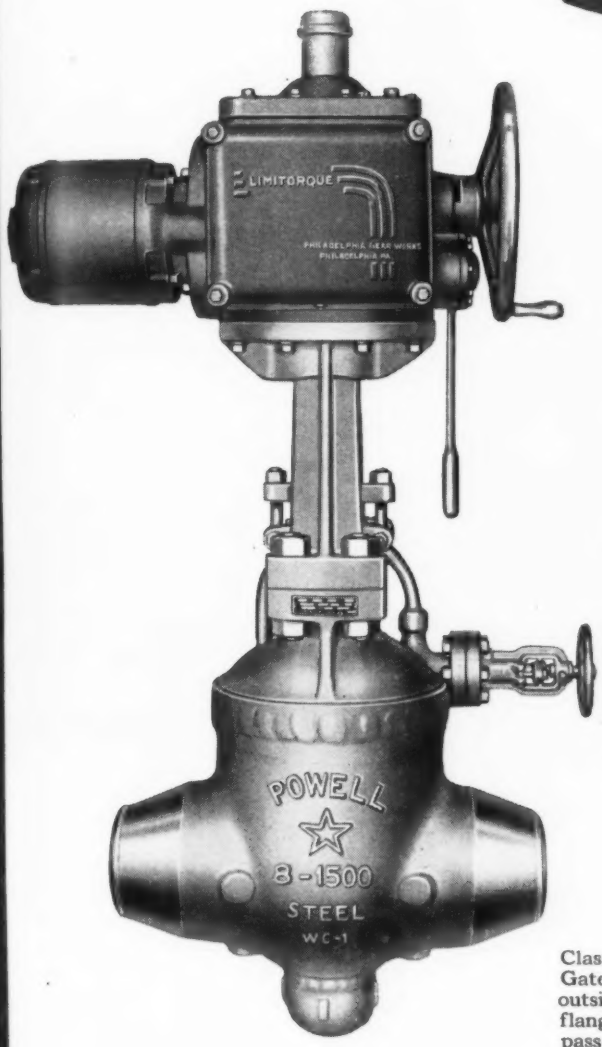
POWELL

THE valves shown here are a few of the complete POWELL Line of Cast Steel Valves, built especially to meet the flow control requirements of the Power Plant of to-day—and TO-MORROW.

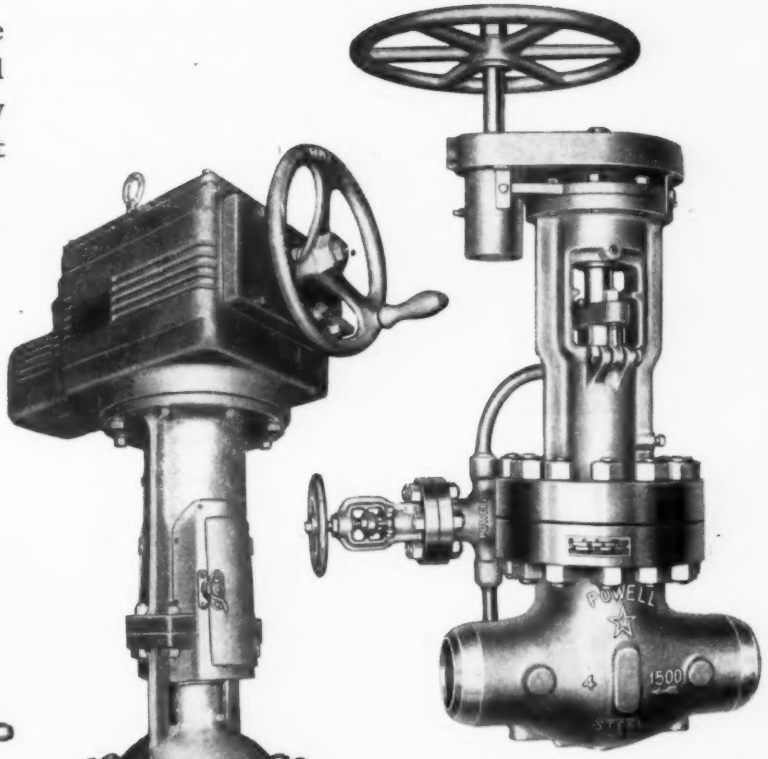
The Wm. Powell Co.

Dependable Valves Since 1846

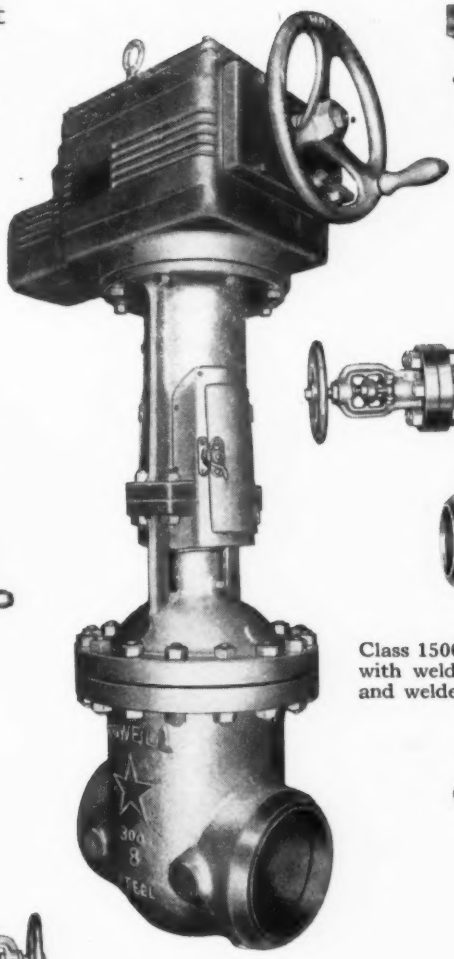
Cincinnati 22, Ohio



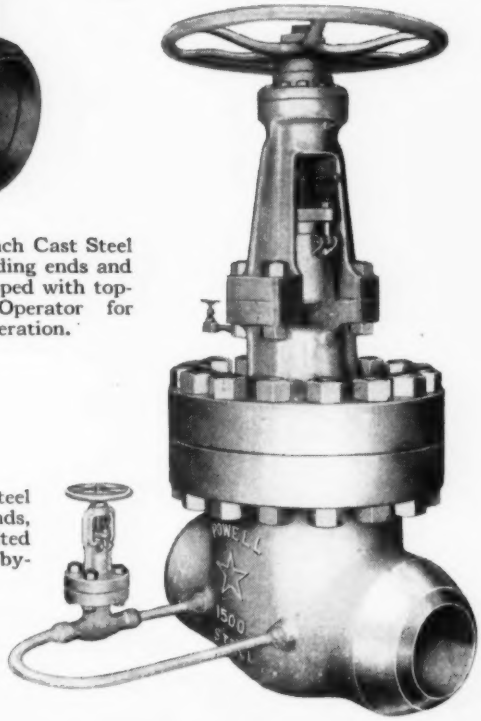
Class 1500-pound, 8-inch Cast Steel Gate Valve with welding ends, welded bonnet, special by-pass and welded sediment and inspection cap. Equipped with top-mounted electric motor operator for quick, positive opening and closing.



Class 1500-pound Cast Steel Globe Valve with welding ends, bolted flanged yoke, and welded by-pass. Spur gear operated.



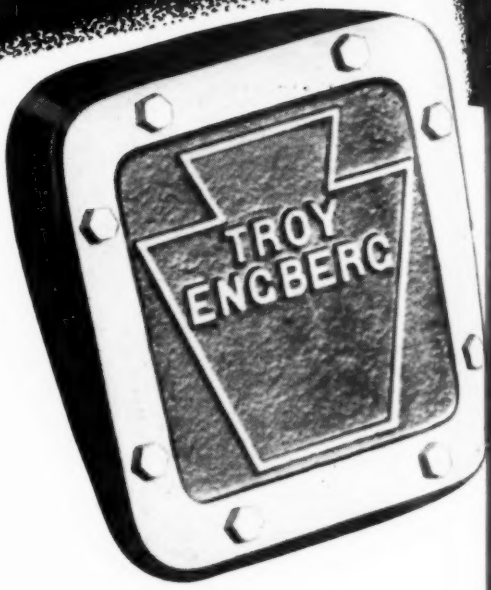
Class 300-pound, 8-inch Cast Steel Gate Valve with welding ends and bolted bonnet. Equipped with top-mounted Electric Operator for fast, safe, efficient operation.

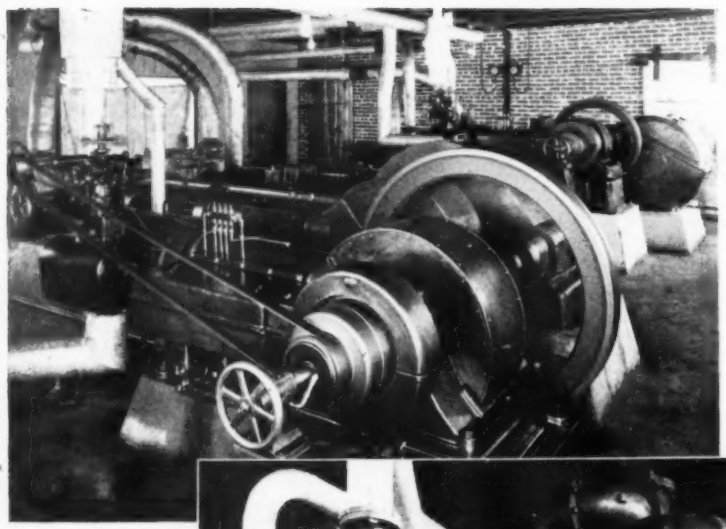


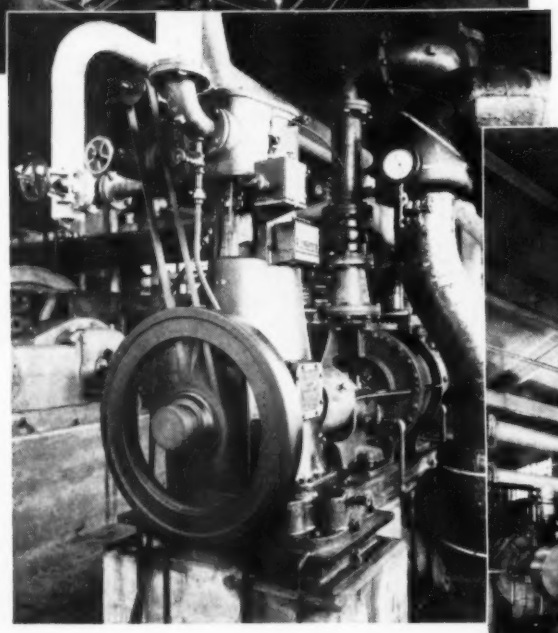
Class 1500-pound Cast Steel Gate Valve, with welding ends, outside screw rising stem, bolted flanged yoke and welded by-pass. Sizes, 6″ to 14″, incl.

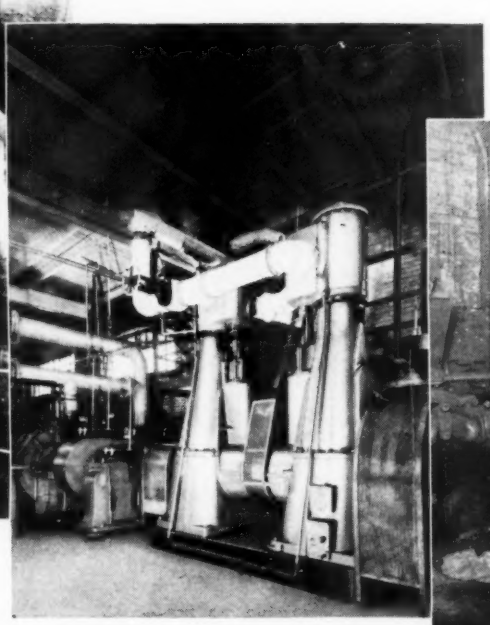
VALVES

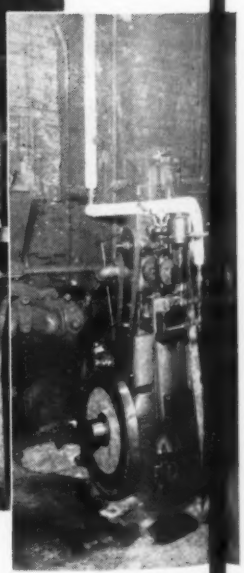
Savings BY THE STEAM ENGINE











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EQUICKLY PAY FOR THE DRIVE

HOW would you rate a drive that brings about such savings (over power costs required for other types of drives) that it would pay for itself and its installation costs in a year or two?

That's the record of the Troy-Engberg Steam Engine in many, many plants where it is driving stokers, compressors, fans, blowers, pumps, generators and other types of equipment.

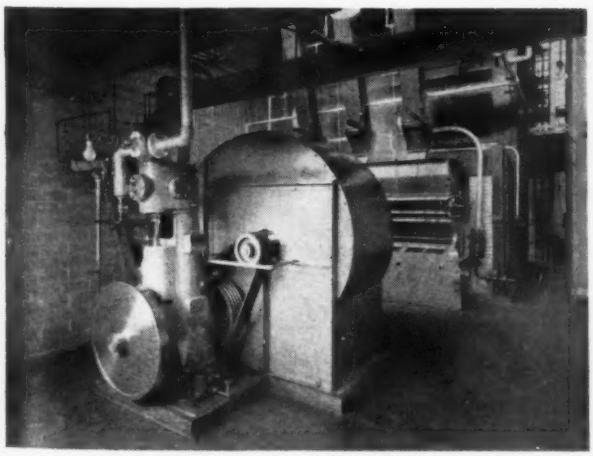
Along with its economy, the Troy Engine offers exceptional flexibility, high starting torque, ability to carry heavy overloads over long periods, and, of course, dependability.

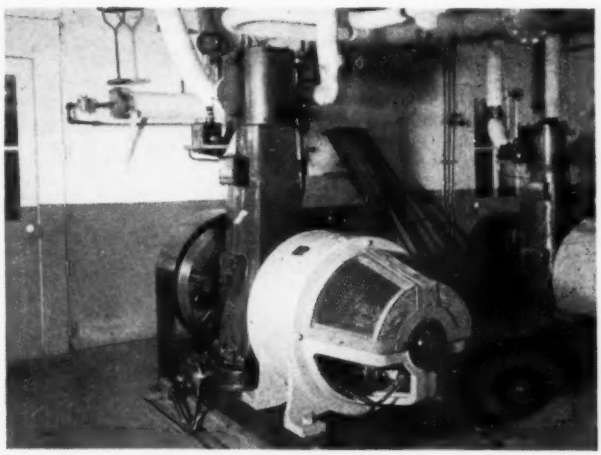
Plant engineers and operating men should always consider the Troy-Engberg Steam Engine when selecting a drive.

THE TROY ENGINE & MACHINE COMPANY

Established 1870

1492 Railroad Avenue **Troy, Pennsylvania**





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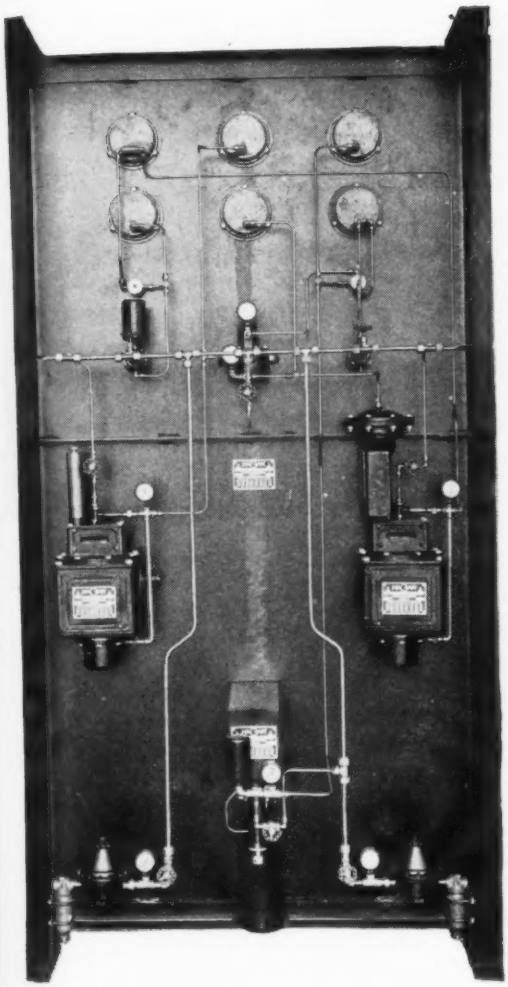
NO ABSENTEE PROBLEM WHEN HAGAN CONTROL IS *on the job!*

This Hagan "Operating crew" is on the job 24 hours a day and no time off for sickness. Its quick response to changes in steam demand saves you up to 10% in fuel consumption. If your skilled operators are off work or called to war, Hagan Control will go on operating the plant at highest efficiency.

round-the-clock worker who doesn't know the meaning of unscheduled lay-off!



Thinks like an engineer. This is the "brains" of the control system—the Master sender which detects load changes and sends the impulses that regulate fuel and air to the most efficient quantities.

IF you could have enough trained men around to do what this famous control system does, they could not do it as well, as reliably or as fast. Certainly not as economically! For this equipment, which "thinks like an engineer and acts instantly," goes on operating efficiently even if some of your operators are absent. It is so simplified as to be almost fool-proof . . . so dependable you have practically nothing to do with it but watch results.

Thousands of America's war industries can thank their stars today that they were farsighted enough to have Hagan installations functioning when the demand came for vastly increased production. They knew it would give them all the steam their boilers were capable of producing and give it as needed, according to the demand.

Hagan Automatic Control is one of the investments in equipment which management really likes to make. It not only starts paying dividends *at once* but will keep on doing so for many years to come.

May we tell you more about it?

HAGAN
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BUROMIN
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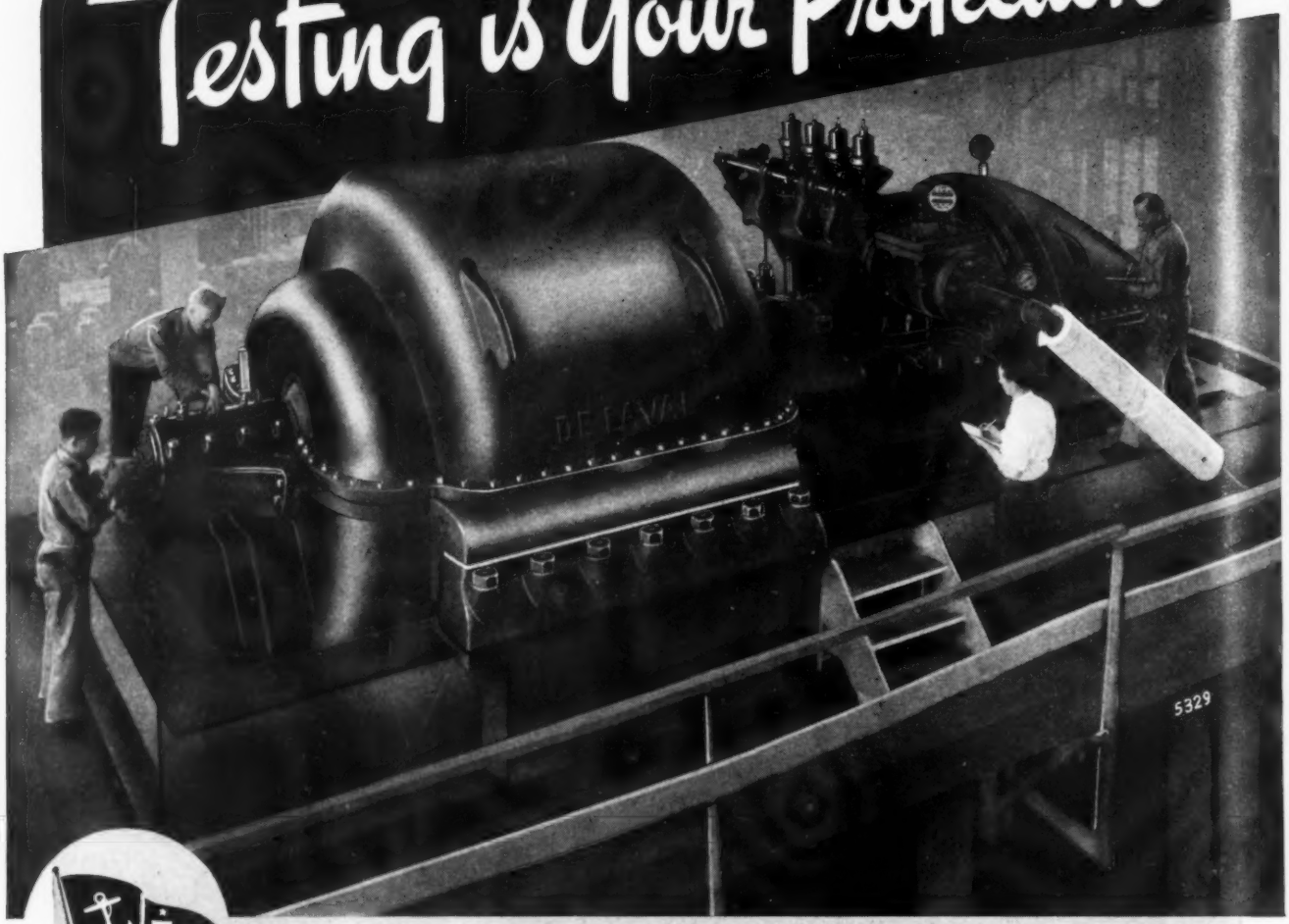
HAGAN CORPORATION · HAGAN BUILDING · PITTSBURGH 30 PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

Testing is Your Protection



90,000 cu. ft. per min. turbine-driven blast furnace blower on test in De Laval Works

The De Laval Testing Division, which is operated as a separate department by competent men who devote their entire time to testing, is of benefit to purchasers of De Laval equipment in two ways:

1. Testing gives assurance that the apparatus meets guarantees as to efficiency, head or pressure, volume or capacity, etc., and that its mechanical operation is satisfactory.

2. The results of tests on each machine enable the De Laval designing engineers to improve and perfect the product.

Where apparatus must be built for a great variety of operating conditions, as in the case of steam turbines, centrifugal pumps and compressors and rotary pumps, a consistent policy of testing is particularly important.

M-26

DE LAVAL *Steam Turbine Co.* **TRENTON 2, N.J.**

MANUFACTURERS OF TURBINES . . . STEAM, HYDRAULIC; PUMPS . . . CENTRIFUGAL, CLOGLESS, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, PROPELLER; PRIMING SYSTEMS; CENTRIFUGAL BLOWERS and COMPRESSORS; GEARS . . . WORM, HELICAL; and FLEXIBLE COUPLINGS

APRIL 1944

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MORE CAPACITY WITH LOWER GRADE COAL

Fuel-wise plants are now converting their boiler units to use local low-fusion ash coals. This change-over saves over-all fuel costs and guarantees a fuel supply that will last, at present mining rates, for centuries.

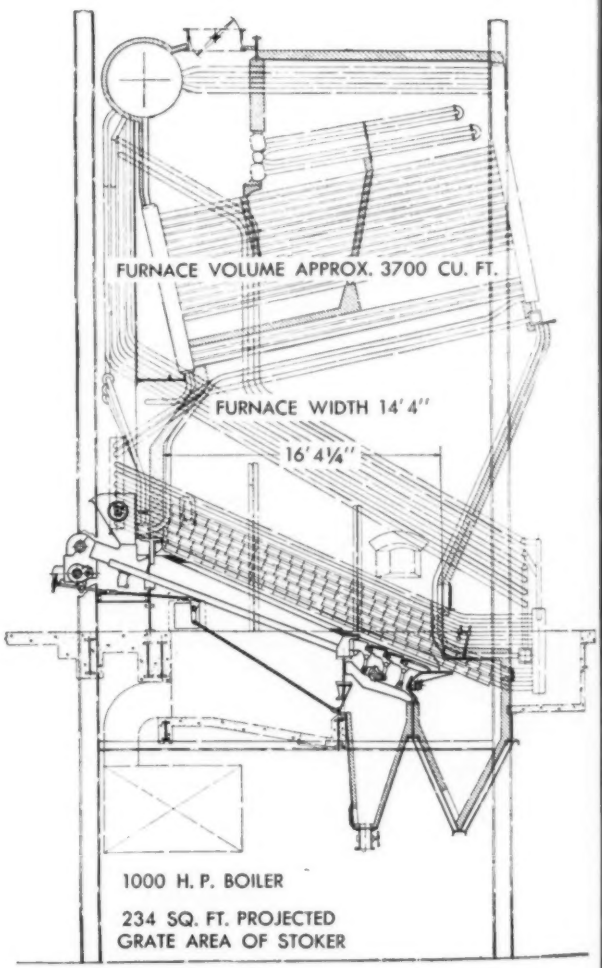
For example, Power Engineers of the American Viscose Company were faced with this problem: One of their largest plants, although located near a major coal field, could not burn local coal with existing equipment. Premium coal, hauled several hundred miles, was expensive and becoming more difficult to obtain. Even with premium coal, load demands could not be satisfied.

The solution: An installation of four Westinghouse Link-Grate Stokers. By this conversion, load demands are met easily with low grade coal. The company is assured of a plentiful coal supply and savings in cost of fuel resulted in an unusually attractive return on the investment. And the first stoker, operated 11,530 hours before it was necessary to replace any stoker parts.

J-50449

CONVERSION DATA

Boiler—Edge Moor—Cross-drum	1,000 hp
Steam Pressure	250 psi
Steam Temperature	580°F.
Feed-water Temperature	225°F.
Stoker—Westinghouse M. R.—	
Continuous Ash Discharge	8 Retort SDL No. 16
Rating, Maximum Continuous	90,000 lbs. per hr.



BEFORE YOU BUY . . .

Look at the Link-Grate

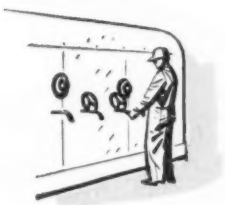
...THROUGH Link-Grate CONVERSION

...and here's why—

BURNS LOW COST COAL

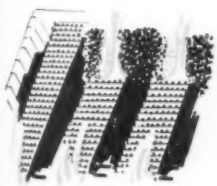
A Link-Grate Stoker will burn any grade of bituminous coal—and burn it effectively. The "up and down" Link-Grate motion maintains a regular combustion rate by continuously processing the fuel bed—keeping it porous—maintaining a uniform flow of gases going through the combustion zone.

REQUIRES FEW ADJUSTMENTS



Once the basic cycle of operation is established for a particular boiler load and type of fuel, thorough combustion is practically automatic. The few adjustments necessary can be made easily—quickly. Constant Link-Grate movement prevents ash accumulations—keeps ash discharge continuous.

HAS UNRESTRICTED FUEL BED FLOW



The Link-Grate motion facilitates normal movement of the fuel bed over the underfeed section—even at low loads. There are no clinker problems because burning lanes are kept clear. Pores are never closed to cause large clinker formation.

HANDLES ALL TYPES OF LOADS

Link-Grate Stokers meet any steam demands on the boiler. Since Link-Grate motion keeps the fuel bed porous under all conditions, the fire is always sensitive to air flow. Changes in air supply, corresponding to changes in steam demand, are effective immediately.

The Westinghouse Stoker Engineer near you will be glad to show you a Link-Grate Stoker installation in your locality. Just call your nearest Westinghouse office for details. Westinghouse Electric & Mfg. Company, East Pittsburgh, Pennsylvania.

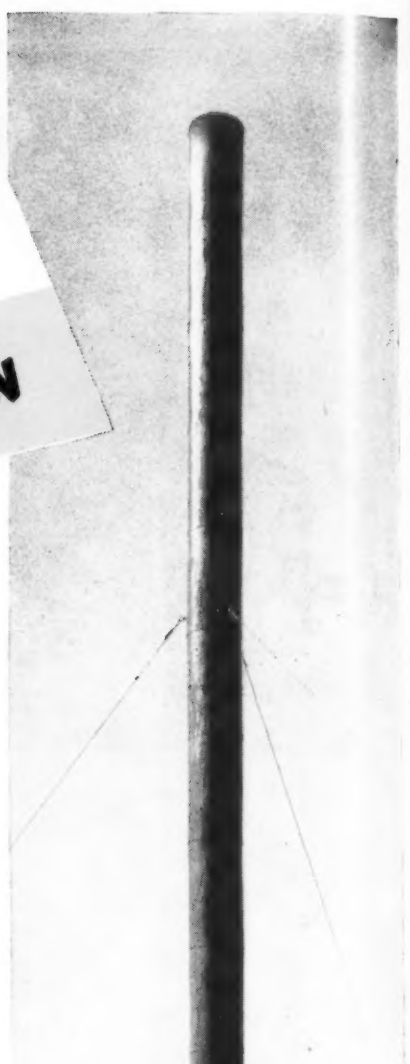
Westinghouse PLANTS IN 25 CITIES... OFFICES EVERYWHERE **STOKERS**

WESTINGHOUSE W

The Old Stack Died Too Soon . . .

so the new one is

BYERS WROUGHT IRON



When the power plant stack (made of ordinary material) at the Windber, Pa., Hospital failed after only 11 years of service, the engineer reviewed the possibility of getting greater durability before he wrote his specifications. The result is shown: the new stack is Byers Wrought Iron.

Any sound solution of a stack problem must start with the corrosive conditions involved. Carbon dioxide is produced whenever fuel is burned. If this gas is absorbed by moisture, it makes a highly destructive acid. If sulfur is present in the fuel, it too will form a corrosive acid. The condition may be aggravated at any time by increase of moisture in the flue gases, or by the cooling of the gases—through the use of economizers, or through intermittent operation which allows stack temperatures to drop below the dew point.

No ferrous metal is immune to this acid attack . . . but wrought iron is highly effective in resisting it. The matrix of high-purity iron is threaded with tiny fibers of glass-like silica slag. These fibers diffuse and disperse the corrosive attack, and so combat the pitting and rapid penetration that generally causes ordinary materials to fail. Further, the initial protective film is firmly anchored, and helps to shield the underlying metal from destruction.

You will find evidences of wrought iron's greater durability all over the country, in stacks that are still serving long after those made of low-first-cost materials have failed. Some of the most dramatic examples are provided by composite stacks. Take the one on a water company's plant, for instance. The top ring of the wrought iron stack required replacement after 30 years of uninterrupted service. An ordinary material was used in the replacement, *which failed after only 5 years.* The second replacement was naturally wrought iron, and it—and the original wrought iron in the lower part of the stack—are still on the job.

If you have a stack replacement problem, why not investigate and see whether wrought iron would make that new stack last longer. Our technical bulletin, "Wrought Iron in Flue Gas Conductors and Coal Handling Equipment" will give you some helpful information . . . and you can always call on our Engineering Service Department for specific service information.

A. M. Byers Company. Established 1864. Offices in Pittsburgh, Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

Corrosion costs you more than Wrought Iron

BYERS
GENUINE WROUGHT IRON
TUBULAR AND HOT ROLLED PRODUCTS
ELECTRIC FURNACE ALLOY STEELS • OPEN HEARTH ALLOY STEELS
CARBON STEEL TUBULAR PRODUCTS

Disposal of Government War *Plants and* Equipment

In the last four years, the Federal Government has spent over fifteen billion dollars on war plants—two-and-one-half times as much as was spent by private investors.

Of this fifteen-billion-dollar government investment, about one-third has gone into facilities for the manufacture of aircraft and for ship construction and repair; another third has gone into plants for production of combat ordnance; and the remaining third has gone into a variety of facilities for making synthetic rubber, metal products, machinery, and miscellaneous equipment.

Most of these plants are in industries that are expanded far beyond peacetime requirements. Furthermore, their convertibility to other civilian uses will, in many cases, be complicated by their specialized equipment and layout, by their tremendous size, and by their uneconomic location. At the moment, it looks as if roughly one-third of the government-owned plants and equipment can be converted fairly readily to peacetime operation, and will, therefore, be easily disposable to private enterprise.

The discovery of unsuspected uses for war plants and equipment may well raise the disposable proportion to one-half or more. The government, at the end of the war, may own about one-eighth of the commercially-usable industrial capacity of the country. It will be by far the largest owner of machine tools; it will own enormous aluminum capacity, magnesium capacity, many miles of pipe lines, and more ships than the entire private shipping industry.

What the government does with its war plants will have a profound effect on the free enterprise system and on all workers, employers, investors, and consumers who have a part in that system. If this problem is handled badly, we may find ourselves enmeshed in a trend toward monopoly and government operation of industry. If the problem is handled well, we shall have taken a big step toward freedom of action in a competitive society, toward full opportunities for business enterprise, toward well-paid productive jobs for workers, and toward a higher standard of living for us all.

Recently, three important events have signalled encouragement. They are the report of Senator George's Committee, the Baruch report, and the report of Senator Truman's Committee. These reports are noteworthy for their competent sizing up of a complex problem, for their recognition of the major responsibility of government in making a successful transition to peace, for their insistence on wise policy and good administration, and for their genuine concern that our productive powers be given full opportunity in a free private enterprise system. These reports agree on basic principles and many specific lines of action. There are, however, important areas of policy formation, organization, and procedure—especially in regard to plant disposal—which remain to be blue-printed.

In formulating the policies and practices to be followed in dealing with government war plants, our major goal must, of course, be a high level of production and employment in private business after the war.

Government operation in competition with private employers and privately-employed workers will not be desirable because it will make investment unattractive to private capital and will limit opportunities for private employment. On the other hand, sales to private buyers which result in increasing the concentration of industry will also be undesirable. We must use this opportunity to strengthen the competitive enterprise system and to move away from, not toward, the concentration of economic power in either public or private agencies.

To accomplish these objectives, a program of action such as follows will be necessary:

1. An adequate reconversion organization will be needed in the government, but its powers and responsibilities should carefully be defined by Congress. Fortunately, an able Administrator of Surplus War Property already has been appointed. It will be essential for him to work in closest cooperation with Congress and with the Armed Forces and other executive agencies. The Office of War Mobilization, and ultimately the President, must be responsible for seeing that the Surplus War Property Administration is not sidetracked by the operating agencies and is not dominated by their sheer size. Funds must be supplied generously to the Surplus War Property Administrator, so that he can set up an organization adequate to cope with this huge and complex job. Business, too, must be generous in loaning top-flight executives for postwar government service.

2. One of the first acts of the Surplus War Property Administration will have to be to assemble a complete inventory of government war plants and equipment, to make possible the planning and control of the disposal process, and to form the basis of catalogues of property available for sale.

3. Cooperation between the executive and legislative branches of the government will be needed to develop at least tentative plans with respect to matters of public policy which are of special importance to a successful transition to peace. Among these matters are the size of the military establishment to be maintained in time of peace, the stand-by facilities and reserves of materiel necessary for our security in case of future war, and our policy regarding import and production of synthetic rubber and other critical and strategic materials.

4. The Surplus War Property Administrator should

obtain from the Armed Forces, acting under congressional directives, specification of those plants which are needed to supply our peacetime Army and Navy and to provide the essential reserve capacity in case of war.

5. The Surplus War Property Administrator should select certain war plants as depots in which to store the huge surpluses of inventories and equipment which will have to be removed from private and government-owned factories in order to make possible their conversion to civilian use.

6. Those plants which are not desired by the Army or the Navy, which are not needed for storage, and which clearly will be unsuitable for peacetime utilization should be scheduled for dismantling and disposal piecemeal.

7. The two or three billion dollars' worth of government facilities intermingled with private plant should receive attention with a view to early sale, temporary continuance or use under lease, or early removal.

8. The various plants and pieces of equipment available for sale to private business should be classified conveniently, catalogued, and advertised to prospective buyers or lessors. Before the Surplus War Property Administrator offers, for private sale, plants and equipment not desired by the Army or the Navy, he should ascertain whether the plants or equipment are desired by other branches of the government or by public corporations such as the T.V.A.

9. Whenever property can be sold at prices approximating depreciated reproduction cost, that will be by far the best solution. Generous time-payment terms should be offered. In many cases the government may be unable to sell the property for reproduction cost less depreciation, for the simple reason that no one would think of reproducing it. The property may already be partly obsolete or, because of its size, location, or other characteristics, may only be moderately well suited for commercial use. This should not prevent the government from selling it, provided a price which fairly represents the worth of the property can be obtained. The best test of that worth is the price produced by active bidding under favorable market conditions.

10. When property cannot be sold at a fair price, temporary leases with options to buy should be employed to get the facilities into productive use. This should not, however, be done on terms which would cause unfair competition or create clearly excessive capacity in an industry. And the lease must be temporary; it must not be the means to prolong government control or ownership.

11. The government should offer the strongest possible resistance to local groups or industry groups seeking subsidies for continued operation of war properties. Subsidies will burden the Treasury and lead to inefficient use of resources. They will be justified only to maintain facilities needed for national security.

12. The plants and equipment offered for sale and lease should include sufficient quantities in small enough lots to satisfy the demands from small business. The war has tended to concentrate production in larger plants. After the war, we should seek a wider distribution of the government war facilities.

13. Insofar as possible, war buildings and equipment should be offered for sale in units which can be purchased by businesses in peacetime industries. Many of these industries have had to get along during the war without adequate replacement and expansion, and will be ready to buy if they are able to get what they want from the government. This is a particularly desirable market for surplus government property since these industries are, for the most part, not faced with the problems of excess capacity.

14. Property, such as machinery and other movable equipment, which is in excess of our domestic requirements or is more urgently needed by other countries, should be exported. We shall need, and can take, large supplies of raw materials in return.

15. Property which is not needed by the Armed Forces, which cannot be sold or leased on terms which would be fair to competing plants, which cannot be dismantled and distributed piecemeal, and which cannot be sold abroad, should be scrapped as soon as its non-disposability is apparent. The disposal of war plants should be completed within three to five years.

16. All negotiations for sale or disposal should be matters of open public record. As Mr. Baruch has said, the process must be conducted in a goldfish bowl. This is as much for the protection of business as for the protection of the government.

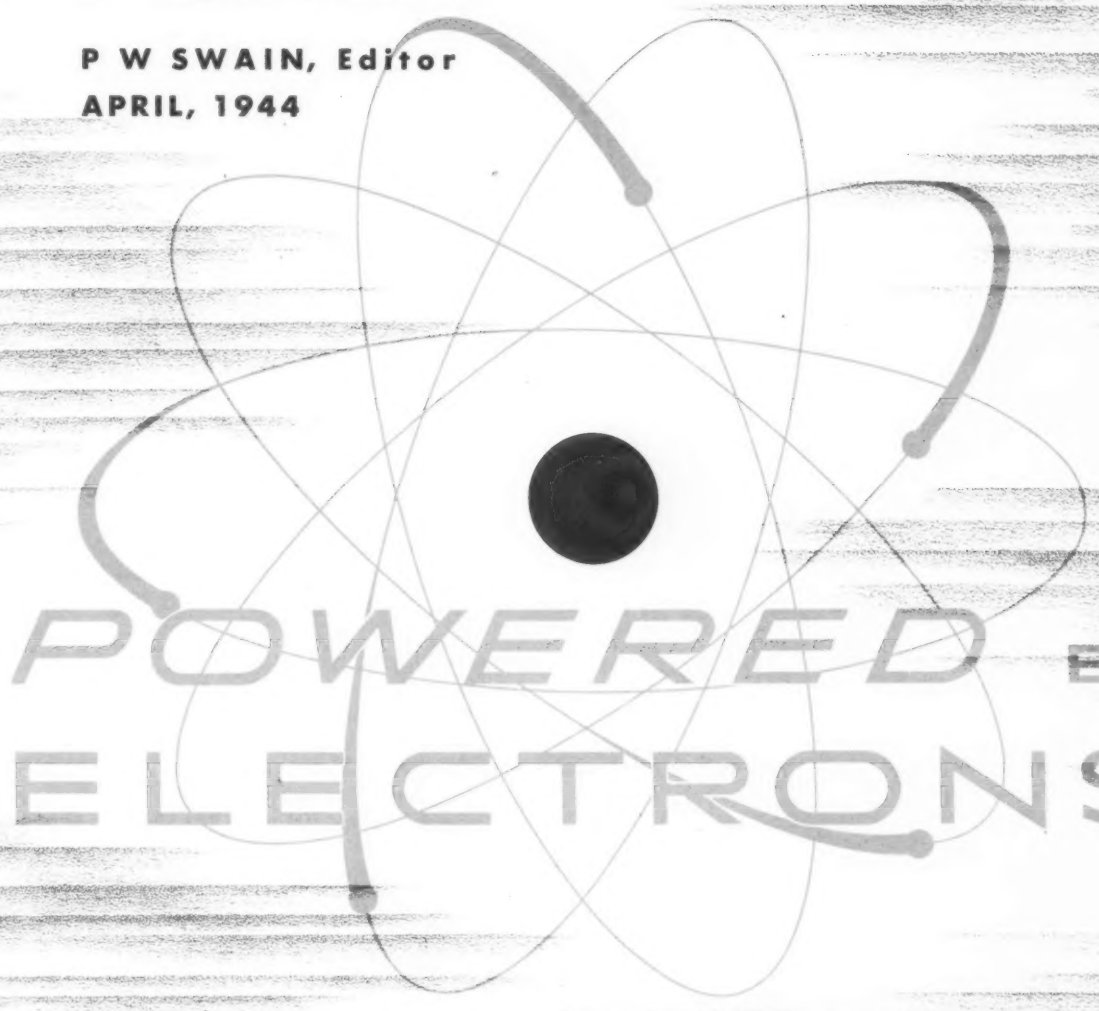
These courses of action do not include everything that must be done, but they do indicate the general lines along which our surplus war plant disposal must proceed if it is to avoid precipitating needless transition unemployment.

The gravest danger of all will be red tape, intergovernmental conflict, and inadequate administration. It would be a great misfortune for the executive and legislative branches to quarrel over details of organization when they agree on the basic principles to be followed in handling the problem. Obviously, the Surplus War Property Administration must cooperate with Congress and look to it for policy guidance. Just as obviously, the disposal problem will involve great difficulties of administration which must not be complicated by congressional interference. We shall need the best we can get in careful policy making, detailed planning, good organization, and courageous action. This is a matter of vital importance to every American. The stakes are too high to tolerate poor administration or petty politics.

President, McGraw-Hill Publishing Company, Inc.

POWER

P W SWAIN, Editor
APRIL, 1944

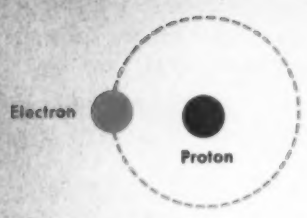


POWERED BY ELECTRONS

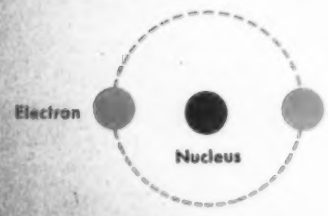
By F A ANNETT, Associate Editor

ELECTRONICS—"the art of producing and controlling free electrons"—has invaded the power field so rapidly that many an engineer finds himself face to face with electronic devices, which he must operate but which he does not understand. To help him meet this new challenge, POWER devotes to electrons, and to electron tubes and their applications, this special section, No. 46. It shows how the tubes produce and control the flow of electrons, and explains typical, important applications to power and process. In presenting electronics without glamour or mystery, the author aims to give the engineer reader a sound, practical start. From there on, only his own experience and reading can keep him in step with this rapidly expanding "art."

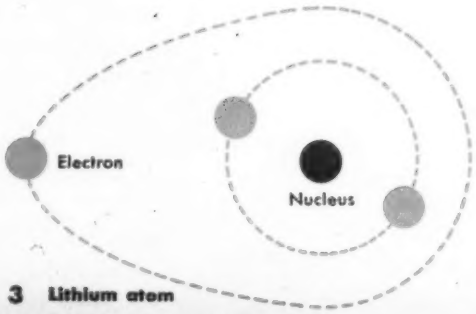
THE ELECTRON



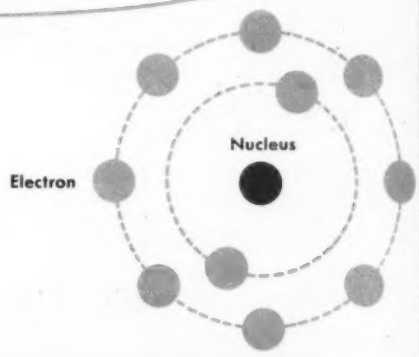
1 Hydrogen atom



2 Helium atom



3 Lithium atom



4 Neon atom

OPERATION of all electronic devices involves methods of producing a flow of electrons and control of their flow. Therefore, we will first find out what electrons are, how they become available, and what some of the laws are that govern their action under different conditions.

All matter is composed of one or more of 92 elements, such as hydrogen, oxygen, nitrogen, carbon, lead, iron, silver, gold, etc. Smallest possible division of any element that can exist is called an atom, which is composed of positive and negative particles of electricity. Negative particles are electrons; positive particles are sometimes called positive electrons, but more generally protons. Other particles, such as neutrons and positrons, have been found in the atom, but for our purpose we need consider only electrons and protons.

Electrons and protons are arranged in well-defined patterns in atoms. The hydrogen atom is the simplest example. This solar system has as its sun, or nucleus, a single proton with a plus electrical charge about which moves a single electron with a negative electrical charge, Fig. 1. Atoms and electrons cannot be seen under the most powerful microscope, the electron diameter being about a trillionth of an inch. To the engineer, such dimensions mean only that electrons are infinitesimally small.

In a hydrogen atom at ordinary temperature, the electron's velocity around its proton is about 75 miles per sec. As we will see later, when heat or light increases the energy of electrons, they accelerate in their orbits until some fly out into space. Thus, they may approach the speed of light.

Next to the hydrogen atom in the electron scale is the helium atom. Around its compact nucleus two electrons travel in an orbit, as in Fig. 2. An atom of lithium (a silvery metal) has two electrons in an inner circular orbit, as in the helium atom, and one electron in an outer elliptical orbit, rotating about a compact nucleus, as in Fig. 3.

Number of electrons in the outer orbit increases by one for each of seven more elements until the atomic scale reaches neon, with two electrons in its inner and eight in its outer orbit, Fig. 4. In the next element, sodium, another electron is added in a third orbit. Adding one electron for each succeeding element continues through the scale to uranium, with 92 electrons divided among several orbits—all rotating about a nucleus. The figures show all electron orbits in the same plane, but actually each orbit is in a different plane, somewhat as on page 63.

In the atom's electron system, the nucleus has many secrets which physicists have not fathomed. The hydrogen atom's nucleus is a single positive electron—a proton. But all other atoms, according to one conception, have a nucleus of electrons and protons, each proton carrying a positive electric charge equal to that of an electron. There are one half as many electrons as protons. For example, the helium atom's nucleus has four protons and two electrons, as in Fig. 5. The two electrons neutralize the charge of two protons. Positive charges of the remaining two protons are balanced by the two electrons in the outer orbit, Fig. 2.

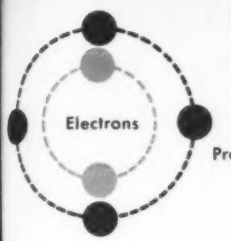
A lithium atom has six protons in its nucleus with three electrons, Fig. 6. This leaves three protons to be balanced by three electrons in the outer orbits. This system of building atoms for the 92 elements continues to uranium atom, which has 184 protons and 92 electrons in its nucleus and 92 electrons in outer orbits. Always the number of electrons equals the number of protons.

Electric current flow through a solid conductor appears to be a slow drift of so-called free electrons in the conductor. Just how they become available has not been definitely established. Because atoms in a conductor constantly move about at random, one conception assumes that, while electrons rotate in orbits about the nucleus of each atom, an electron may at times be as close to another atom's nucleus as to its own.

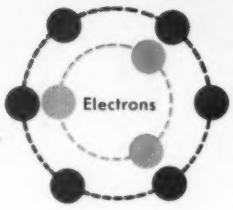
Fig. 7 shows one way in which this could happen. If two lithium atoms drift to the position shown, electron *A* is as close to the adjacent atom's nucleus as to its own, and is attracted equally by both. In such a position, electrons do not have a resultant force acting on them and are free to join other atoms. A voltage, applied to the ends of the conductor, causes some of these free electrons to drift toward the positive terminal of the circuit, their charge being negative.

For many years, it was generally believed that electric current flowed through a conductor with the speed of light. Now, we know that electron flow, the so-called electric current, is slow un-

5 Helium nucleus

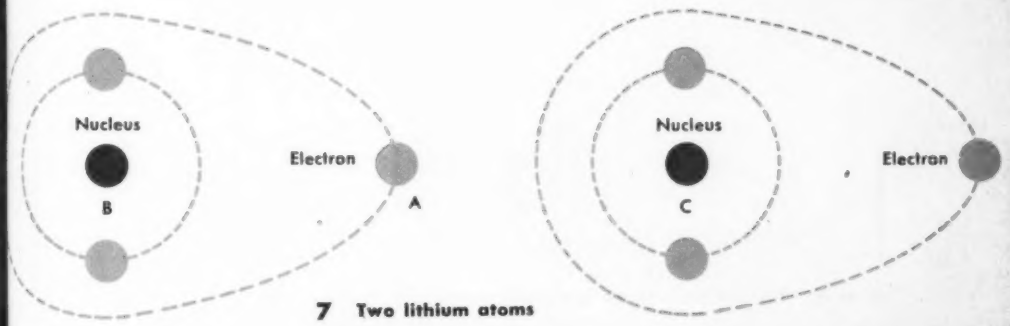


6 Lithium nucleus



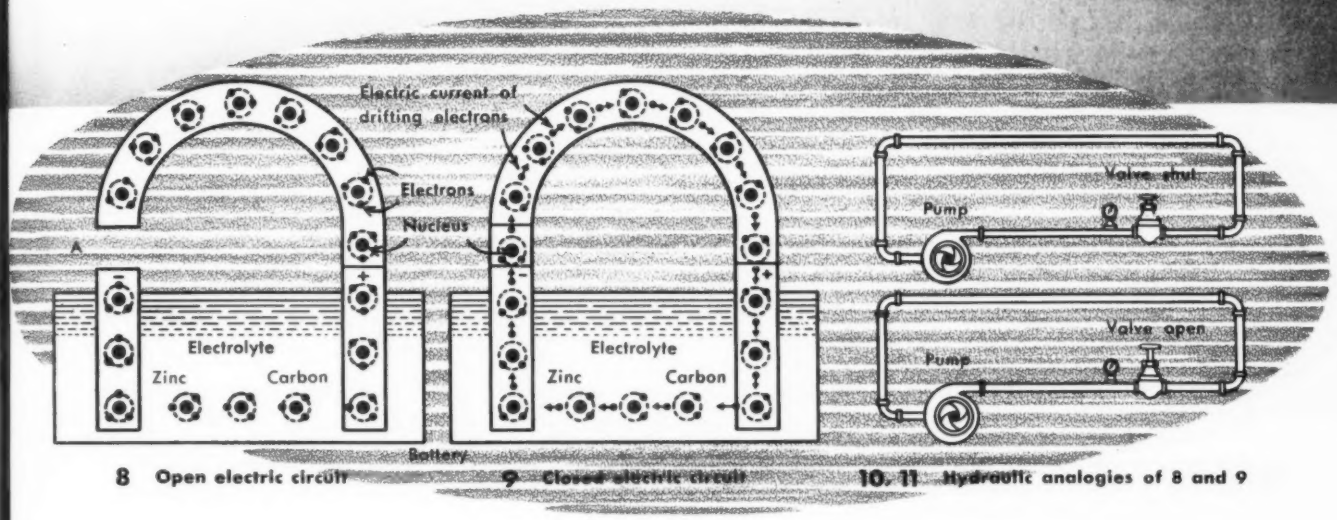
KEY TO FIGURES

1 The hydrogen atom has a single proton about which rotates a single electron. **2** In the helium atom, two electrons rotate about a positive nucleus. **3** A lithium atom is similar to a helium atom, with a third electron added in an elliptical orbit. **4** A neon atom has ten electrons, two in an inner and eight in an outer orbit rotating about a nucleus. **5** The nucleus of a helium atom contains two electrons and four protons. **6** A lithium-atom nucleus contains three electrons and six protons. **7** Two lithium atoms arranged so that electron *A* is as close to nucleus *C* as to nucleus *B*, and consequently is free



7 Two lithium atoms

8 Assumed arrangement of electrons when electric circuit is open. **9** Electrons flow from one atom to the next when circuit is closed. **10** and **11** Hydraulic analogies of the electric circuits shown in figures 8 and 9



8 Open electric circuit 9 Closed electric circuit 10, 11 Hydraulic analogies of 8 and 9

der normal conditions. When a voltage is applied to the ends of a conductor, there appears to be a coordinated drift of free electrons from one atom to another.

Fig. 8 and 9 give an elementary idea of electron flow in an electric circuit. In Fig. 8, the circuit is open at *A*, and each atom represented by a nucleus with three electrons arranged symmetrically around it. When the circuit is closed, as in Fig. 9, to apply battery potential to it, there is a mutual exchange of electrons between the atoms, as electrons with arrowheads indicate: Thus, effects of a comparatively slow flow of electrons are felt through the circuit almost instantaneously.

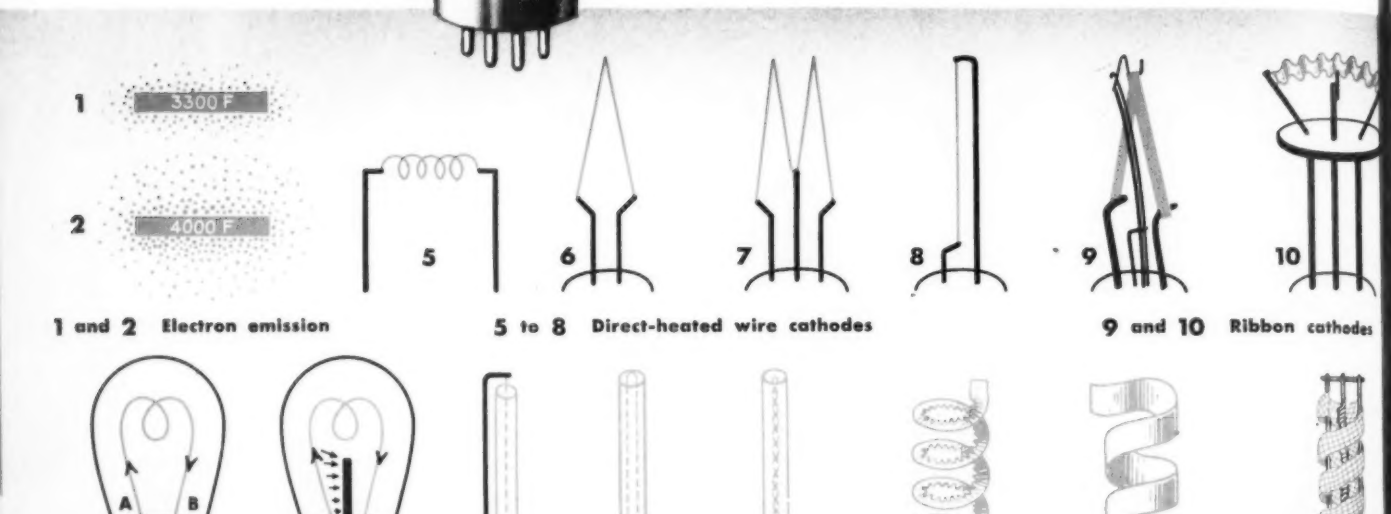
Electron flow is like water flow through a pipe. Assume Fig. 10, a centrifugal pump connected in a closed pipe circuit filled with water and with the valve closed. If the pump operates, it builds up a pressure on the valve's discharge side, but no water flows. If the valve is opened, Fig. 11, water flows in all parts of the circuit simultaneously. That is, the instant water flows out of pump's discharge, it begins to flow into its suction. Even though flow may be a fraction of an inch per second, its effects are felt in all parts of the circuit almost at once. Of course, with water in a pipe its total volume moves, whereas in an electrical circuit, electrons of the atoms move.

Velocity of electrons through the circuit varies over a tremendous range. In solid conductors carrying normal currents, calculations indicate that electrons drift from negative to positive end of the conductor at about 0.01 in. per sec. Even when current density makes the conductor red hot, coordinated electron velocity is around 0.25 in. per sec. On the other hand, in a vacuum tube electrons have been observed moving at 167,000 miles per sec, and they may approach the velocity of light – 186,000 miles per sec. Electron movement in a vacuum tube differs from that in a solid conductor, as will be shown later.

In Fig. 9, for simplicity we showed a current flow of a single electron through the circuit. In practice, however, even a small current flow requires a coordinated drift of an inconceivable number of electrons. For example, in a continuous flow of one ampere, 6.3 billion billion electrons pass a given point in a circuit per second. This is an ampere-second, or coulomb.

These simple concepts of electrons and structure of matter are necessary background for understanding construction and operation of electron tubes and their applications. Some good books for further study are: *Electron Tubes*, by John H Morecroft, and *Principles of Electronics*, by Royce G Kloeffler, both published by John Wiley & Sons, New York; *Electronics at Work*, by Charles R Underhill, and *Electron Tubes in Industry*, by Keith Henney, published by McGraw-Hill Book Co, New York.

THE ELECTRON T



WE LEARNED ON THE PRECEDING PAGES how electrons are arranged in atoms and how they act under different conditions. Here we will find out how they are released from atoms and put to work.

Electrons may be released from atoms of solids or liquids in several ways, but the two that interest us most are (1) thermionic emission, when electrons actually fly into space from a solid whose temperature has been sufficiently increased, and (2) photoelectric emission, when electrons are released from a sensitized plate by application of light.

Solids emit electrons at varying temperatures: When tungsten is heated to about 3300 F, electrons of some of its atoms reach a speed of 620 miles per sec, break through the metal's surface, and fly into space, Fig. 1. As metal temperature increases, electrons speed up and more fly from the surface, Fig. 2. Number emitted increases rapidly with temperature, 4000 F releasing about 75 times as many as 3300 F.

When electrons leave a metal surface, their positive protons are left behind, and the metal becomes positively charged. Unless there is a stronger external positive force to act on the electrons than that of the parent metal, most of them are attracted back home. As a result, from a red-hot metal surface, under no external influence, electrons are being emitted continually, but are also being attracted back into the surface again. This action is very much like popping corn. As the kernels reach a given temperature they pop and fly out in the popper, only to fall back into the mass again.

Our knowledge of thermionic emission dates back 200 years, when it was discovered that the zone surrounding a hot body is a conductor of electricity. Now we know that this zone is a conductor because electrons are emitted by the hot surface into the adjacent space.

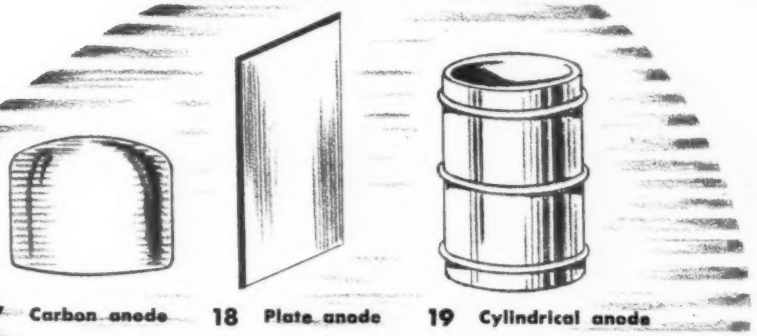
When Edison was experimenting with his incandescent lamp, he found that current flowed between the filament's two ends at their supports inside the lamp, *A* and *B*, Fig. 3. When he placed a plate inside the filament, a current flowed to it when connected to the positive line, Fig. 4, but did not flow when connected to the negative line.

As explained on the preceding pages, current flows through the lamp filament from negative to positive line, Fig. 4, heating the filament to a temperature that emits electrons. Some are attracted to the plate which, being connected to the positive line, is at a positive potential. Number of electrons flowing in the circuit is a measure of the current. It does not flow when the plate is connected to the negative side because, being at a negative potential, it repels negative electrons.

The modern two-element electron tube, Fig. 37, has the same elements as Edison's incandescent lamp with a plate, Fig. 4. In Fig. 37, a filament when heated produces electrons. It is surrounded by a plate in the form of a thin metal cylinder—both contained in a high-vacuum glass bulb.

Electron-tube filaments, or cathodes, are made of several materials, or combinations of them. Included are pure tungsten, thoriated tungsten, nickel alloys and platinum coated with oxides of barium, cesium or strontium, and other elements. These filaments may be divided into two groups:

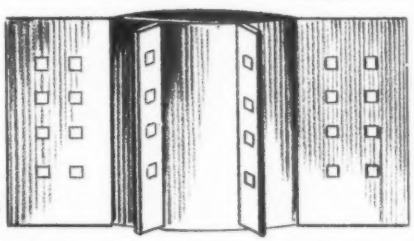
TUBE



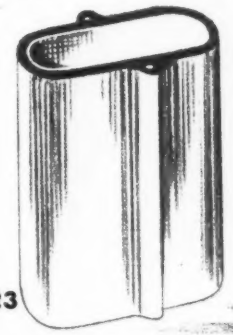
17 Carbon anode 18 Plate anode 19 Cylindrical anode

CATHODES

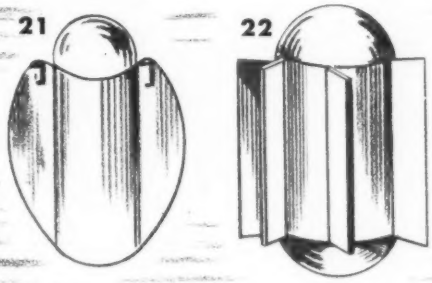
1 and 2 As metal temperature increases, electrons speed up to where they fly off into space. **3 and 4** Edison found that an electric current flowed from the filament of an incandescent lamp to a plate placed between the filament terminals in the bulb. **5 to 8** Direct-heated wire cathodes used in electron tubes where quick heating of the cathode is required. **9 and 10** Metal-ribbon direct-heated cathodes. **11 to 13** Small cylindrical indirect-heated cathodes. **14 to 16** Metal-ribbon indirect-heated cathodes

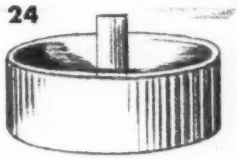


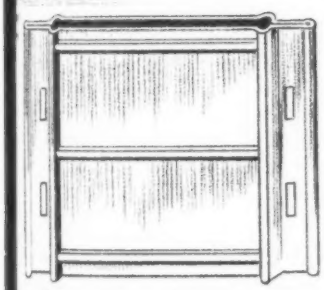
20 to 22 Thin-metal anodes with fins



23 and 24 Carbon anodes







25 Rectangular metal anode

ANODES

17 Dome-shaped metal, or carbon anode. **18** Simple metal plate anode. **19** Metal cylinder anode. **20 to 22** Anodes made of nickel, tantalum or molybdenum provided with fins to increase their heat-radiating surface. **23** Elliptical graphite anode. Graphite is commonly used for anodes because it is readily shaped, has good heat-dissipating qualities and does not warp because of high temperatures. **24** Inverted dome-shaped metal or carbon anode. **25** Rectangular metal anode. Tungsten was one of the first materials used for anodes, but is now little used for that purpose. Molybdenum is now extensively used, its thermal qualities being improved by blasting with carborundum and the addition of fins

(1) Direct-heated filaments have several forms, such as Fig. 5 to 8, of wire, and Fig. 9 and 10, of metal ribbon. Filaments made of tungsten have to operate at about 4000 F to emit sufficient electrons. Thorated tungsten operates at about 3100 F and, because of thorium oxide on its surface, emits about 90 times as many electrons per unit of surface area as pure tungsten, each operating at its best commercial emission temperature. Nickel-alloy filament, such as nichrome wire or ribbon coated with oxides of cesium, barium or strontium, requires only comparatively low temperature, 1400 to 1800 F, to emit electrons freely from the cathode.

(2) An indirect-heated filament is practically a direct-heated filament inclosed in a thin metal sleeve, Fig. 11 to 13, or metal-ribbon spiral, Fig. 14 to 16. Heaters are made of tungsten or tungsten-molybdenum-alloy wire, and their inclosing sleeve or spiral, of nickel alloy coated with electron-emitting material.

The heater is insulated from the sleeve and is used only to bring it and its coating to an electron-emitting temperature. Useful electron emission does not take place from the heater wire. One of the advantages of the heater-cathode design is that it permits close spacing between cathode and plate. Direct-heated filaments are used for quick heating because they heat more rapidly than indirect-heated ones. The latter can heat a much larger electron-emitting surface efficiently, and consequently are used for medium and large currents. Later, we will discuss other means of liberating electrons from a cathode, such as a light beam in a photoelectric tube and an arc in a mercury-arc rectifier.

Every tube has an electron-producing element, just described, and an electron-collecting element, the plate or anode. Earlier anode designs were flat plates, Fig. 18, two frequently being in parallel with the cathode between. Because of its form, the

electron-collecting element became known as the plate, and is often called that even though anodes are generally cylindrical or oval, Fig. 19 to 25.

Tungsten, one of the first anode materials, is now little used. Extensively used is molybdenum, whose thermal qualities are improved by carborundum blasting and adding fins, Fig. 20. Two forms of graphite anodes, another common material, are shown in Fig. 17 and 23. Nickel forms readily into anode shapes but, because it melts at comparatively low temperature, is used only in tubes operating at moderate temperatures. Many properties of tantalum make it desirable. Anodes, made of it, like nickel, usually have fins, Fig. 21 and 22, with a rough surface to increase heat-radiating area. Fig. 24 and 25 show other anodes.

To control current flow through electron tubes, a third element, known as a grid, is added. Some tubes may have two or three grids. They are shaped differently, Fig. 26 to 28, to suit cathode and anode shape and arrangement in the tube. In Fig. 26, the grid is flat, made of fine wire wound on two supporting rods. Fig. 41 shows a circular wire spiral on two vertical supporting rods; and Fig. 27, a cylindrical grid of fine wire mesh. Fig. 28, a disk grid, has holes through which electrons pass. Grids can be made of most anode metals and alloys: tungsten, tantalum, molybdenum, alloys of nickel and manganese, also of molybdenum and tungsten. Grids are sometimes coated with carbon to reduce secondary emission effects (acting like a cathode) and to increase heat dissipation.

Enclosures for cathode, anode, grid and other electron-producing and controlling devices have many forms and sizes, and are of glass or metal. Smaller sizes are usually a glass or metal envelope; larger sizes—mercury-arc rectifiers, for example—are metal tanks.

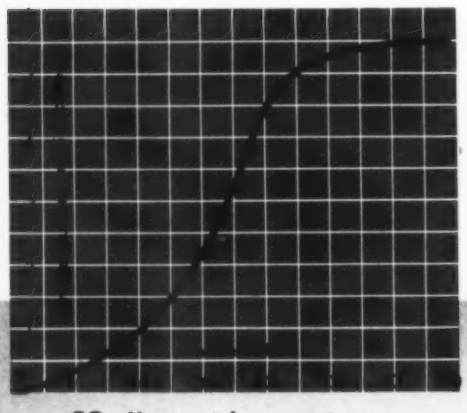
Simplest electon tube is a diode, meaning two elements: filament, or cathode, and plate, or anode, Fig. 37. Its direct-heated cathode (electron-producing element) is a wire loop, and its anode (electron-collecting element) is a metal cylinder. They connect to terminals in the tube base, arranged with prongs to fit a suitable socket.

Electron tubes connected in circuits are usually represented by symbols. Fig. 30 shows the symbol for a two-element high-vacuum tube with direct-heated cathode. If battery *A* of about 5 v is connected across the cathode, Fig. 31, current flows through it from the negative to the positive terminal of the battery, as arrowheads indicate. This current heats the cathode to a temperature where it emits electrons into space, as shown. Since the anode is at zero potential, most of the electrons come back to the cathode for two reasons: (1) When the cathode loses electrons, it tends to become positively charged and attracts electrons back to it. (2) Some of the electrons emitted into space form a negative space charge that repels other electrons and drives them back to the cathode.

The plate, connected to the battery's positive terminal, Fig. 32, is given a low positive potential and attracts some of the negative electrons that the cathode gives off. As a result, a small current flows from anode to battery's positive terminal, through battery to cathode, and to anode.

Connecting a battery, *B*, Fig. 33, in the anode circuit increases positive potential on the anode and increases electron flow from the cathode; that is, it increases current flow through the tube. The anode becomes more positive and attracts a greater number of free electrons if its potential is increased by putting more cells in battery *B*; in other words, current flow increases.

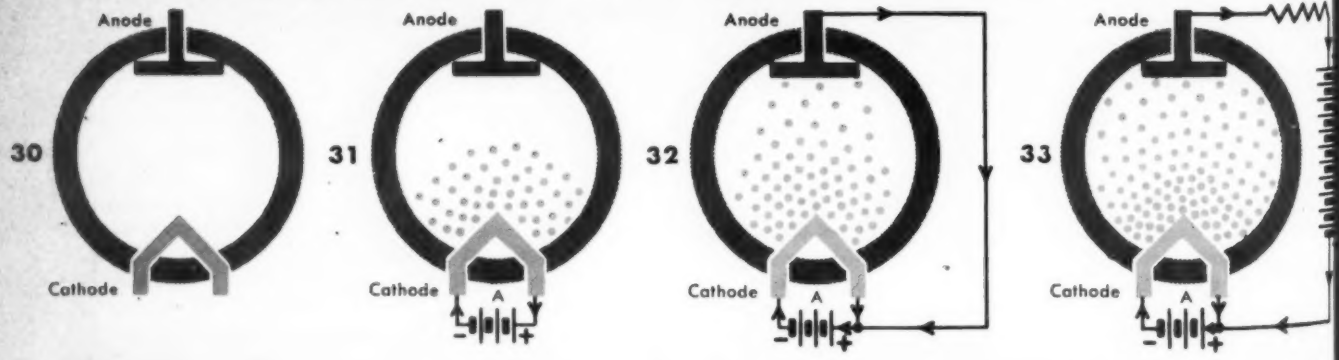
Not all electrons emitted by the cathode reach the anode. Some return to the cathode, while others remain in space between cathode and anode for a short time to produce an effect known as a space charge. As previously mentioned, this space charge tends to repel other electrons, which leave the cathode, and impedes their movement to the anode.



29 Vacuum-tube current curve

29 Approximate curve of current flow through a two-element high-vacu tube when cathode current is held constant and anode voltage gradually creased. At first the current rises slowly, then rapidly, after which its rate increase decreases until a point, known as saturation, is reached. Beyond saturation point current increases only slightly for a given increase in an volts. 30 Symbol of two-element high-vacuum tube with direct-hea cathode. 31 Battery connected to cathode of high-vacuum tube heats cathode and causes it to emit electrons. 32 If the anode is connected

TWO-ELEMEN



30 to 33 Symbols for vacuum tubes with direct-heated cathode

The curve, Fig. 29, shows approximate current flow through a two-element high-vacuum tube when cathode current is held constant and anode voltage gradually increased. At first current rises slowly, then rapidly, after which rate of increase decreases until a point, known as saturation, is reached, beyond which current remains practically constant.

After saturation is reached, if voltage of cathode is increased, its temperature increases, causing increase in its electron emission and current flow through tube. Thus, current flow through a two-element tube may be increased by increasing cathode or anode voltage within the tube's safe limits.

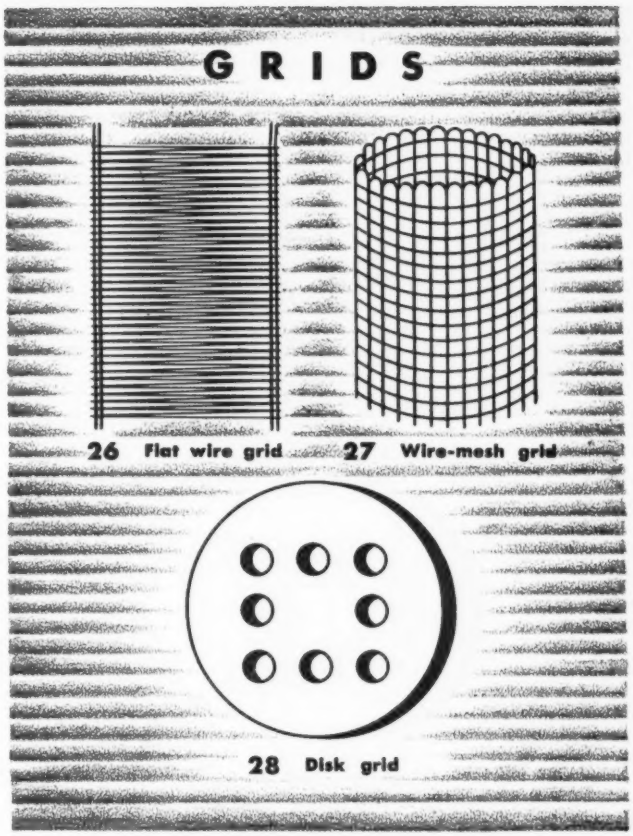
Fig. 34 shows the symbol for a tube with an indirect-heated cathode. It is the same as Fig. 30 except that the cathode is separate from the heater element. This does not complicate the tube circuit because the cathode can be connected to one side of the heater, Fig. 35. Here circuits are the same as in Fig. 33 except that electrons flow from the cathode instead of directly from the heated filament.

A high-vacuum tube has an absolute pressure of only three ten-millionths of an inch of mercury, approximately. To increase current flow many electron tubes contain a small amount of mercury, which is partially vaporized when the tube operates. Other tubes contain an inert gas at low pressure. This gas fills the tube space with atoms which are large compared to electrons. When an electron emitted from the cathode at high velocity collides with a gas atom, the impact knocks one or more electrons out of it, Fig. 39. As a result, number of free electrons is greatly increased in the space between cathode and anode.

Atoms that lose one or more electrons become positively charged because the negative charges of their electrons are less than the positive charges of their protons. These positively charged atoms are called ions and the process of forming them is ionization.

The positive charge on the ions of a gas filled-tube neutralizes most of the negative space-charge effects that exist in a high-

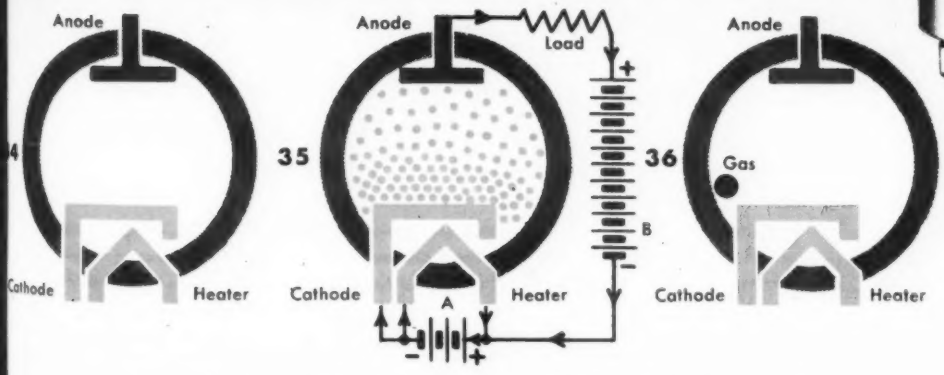
(*Continued on page 72*)



26 Wire grid wound flat on two supports. **27** Cylindrical grid made of wire mesh. **28** Disk grid with holes through it to permit flow of electrons from cathode to anode

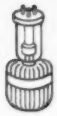
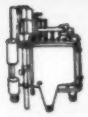
the plus terminal of the cathode battery, a small current will flow from the cathode to anode and back to the battery. **33** Adding battery *B* in the anode circuit increases the anode positive potential. **34** Symbol of two-element high-vacuum tube with indirect-heated cathode. **35** Simple diagram of circuit connections for a high-vacuum tube with indirect-heated cathode. Useful electron emission comes from the indirect-heated cathode and not from the heater. **36** Symbol of gas-filled two-element electron tube with indirect-heated cathode. The black dot indicates gas-filled tube

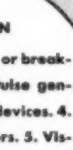
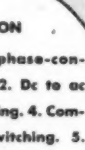
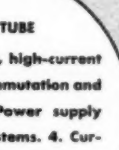
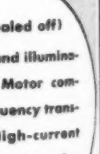
37 Two-element high-vacuum electron tube with direct-heated cathode surrounded by a thin metal anode. Cathode and anode connect to terminals in the base of the tube. When the cathode is heated to a high temperature it emits electrons, part of which flow to the anode when it is connected to an external circuit



34 to **36** Symbols for vacuum tubes with indirect-heated cathode

CLASSIFICATION OF ELECTRON

TUBE IDENTIFICATION						
TYPICAL APPLICATIONS	**TUNGAR OR RECTIGON** 1. Battery-charging installations. 2. Low-voltage, high-current rectifiers. 3. Relaxation oscillators. 4. Voltage rectifiers for ac generators	**KENOTRON** 1. High-voltage, low-current rectifiers for radio receivers. 2. Vacuum-tube voltmeters. 3. Power supplies for broadcast and television apparatus	**PLIOTRON** 1. Communication amplifiers and oscillators. 2. Induction heating. 3. Industrial control. 4. Frequency multipliers and dividers. 5. Diathermy uses	**GRID-POOL TUBE** 1. High-voltage, high-current controlled large-power rectifiers. 2. Railway power. 3. Switching and commutation. 4. Current and power control		
INPUT	ELECTRICAL					
OUTPUT	ELECTRICAL ENERGY					
ELECTRON SOURCE	THERMIONIC CATHODE				POOL CATHODE		
CONTROL METHOD	NONE			ELECTROSTATIC		NONE	ELECTROSTATIC	IGNITER ELECTRODE
CONTROLLED-REGION CHARACTER	H-p GAS	L-p GAS	VACUUM	GAS OR VAPOR	VACUUM	VAPOR	VAPOR	VAPOR
TUBE NAME	TUNGAR OR RECTIGON	PHANOTRON	KENOTRON	THYRATRON	PLIOTRON	POOL TUBE	GRID-POOL TUBE	IGNITRON
FUNCTION: RECTIFIER OR SWITCH								
CONTROLLED RECTIFIER								
AMPLIFIER								
OSCILLATOR, GENERATOR OR INVERTER								
VOLTAGE REGULATOR								
WAVE-FORM ANALYSIS								
LIGHT DETECTION AND MEASUREMENT								
PRODUCTION OF RADIANT ENERGY (Usually light)								

TYPICAL APPLICATIONS	**PHANOTRON** 1. Voltage—limiting or breakdown devices. 2. Pulse generators. 3. Trigger devices. 4. Relaxation oscillators. 5. Visual indicators. 6. Rectifiers	**THYRATRON** 1. Voltage- or phase-controlled rectifier. 2. Dc to ac inverter. 3. Welding. 4. Commutation and switching. 5. Speed control. 6. Timing	**POOL TUBE** 1. High-voltage, high-current rectifier. 2. Commutation and switching. 3. Power supply for railway systems. 4. Current and power control	**IGNITRON (Sealed off)** 1. Spot-welding and illumination control. 2. Motor commutation. 3. Frequency transformation. 4. High-current rectifier. 5. Dc to ac inversion
TUBE IDENTIFICATION				

Courtesy *ELECTRONICS* and *PRODUCT ENGINEERING*

GLOW TUBE

1. Voltage regulator and stabilizer. 2. Visual indicator. 3. Relaxation oscillator. 4. Production of light. 5. Rectification. 6. Protection of circuits

X-RAY TUBE

1. Medical examinations. 2. Industrial examinations of products. 3. Crystal examination. 4. Detection of forged or altered paintings

CATHODE-RAY TUBE

1. Television-receiving tube. 2. Visual indicator for electrical measurements. 3. Application to industrial measurements. 4. Brain-wave studies

STROBOTRON

1. Photographic control tube. 2. Intermittent light source. 3. Stroboscopic measurements. 4. "Slowing" recurrent moving mechanisms

VACUUM PHOTOTUBE

1. Light and color measurement. 2. Spectro-photometers. 3. High-temperature measurement and control. 4. Glare measurement

ENERGY							RADIANT ENERGY (Light)		
		RADIANT ENERGY (Light)					ELECTRICAL ENERGY		
COLD CATHODE		THERMIONIC CATHODE				COLD CATHODE	PHOTOELECTRIC CATHODE		
NONE	ELECTROSTATIC	NONE	ELECTROSTATIC	ELECTROSTATIC	ELECTRO-MAGNETIC	ELECTROSTATIC	RADIANT ENERGY (Light)		
GAS	GAS	VACUUM	VACUUM	VACUUM	VACUUM	GAS	GAS	VACUUM	VACUUM
GLOW TUBE	GRID-GLOW TUBE	X-RAY TUBE	ELECTRON-RAY TUBE	CATHODE-RAY TUBE	CATHODE-RAY TUBE	STROBOTRON	PHOTOTUBE	PHOTOTUBE	SECONDARY MULTIPLIER
					Mag Def				

GRID-GLOW TUBE

1. Controlled voltage regulator and stabilizer. 2. Relaxation oscillator. 3. Remote control. 4. Production of light. 5. Current or power control

ELECTRON-RAY TUBE

1. Visual indicator of voltage. 2. Bridge-balancing indicator. 3. Tuning indicator on radio receivers. 4. Measurement of voltage or current

CATHODE-RAY TUBE

1. Television tube. 2. Measurement of e/m of electron. 3. Visualizing electrical phenomena. 4. Industrial and electrical measurements

GAS PHOTOTUBE

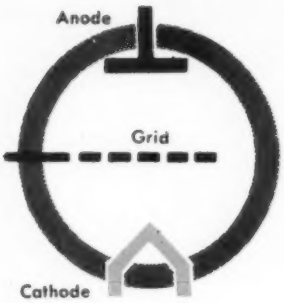
1. Industrial counting, sorting, weighing. 2. Light-control element. 3. Industrial protection and control. 4. Intrusion detector. 5. Sound-on-film

SECONDARY MULTIPLIER

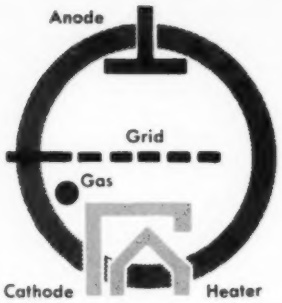
1. Measurement and control of light and color. 2. Measurement of density, transmission, opacity, glare. 3. Light-control device

GRID-CONTRO

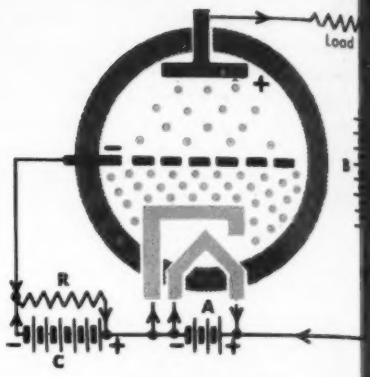
41 Three-element vacuum tube



42 Symbol for three-element vacuum tube

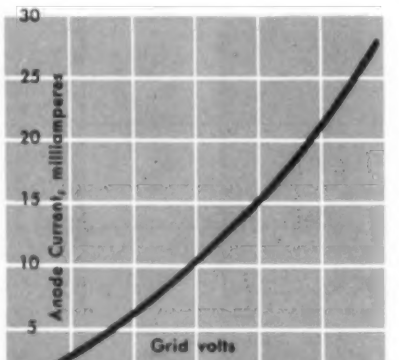


43 Gas-filled three-element electron tube

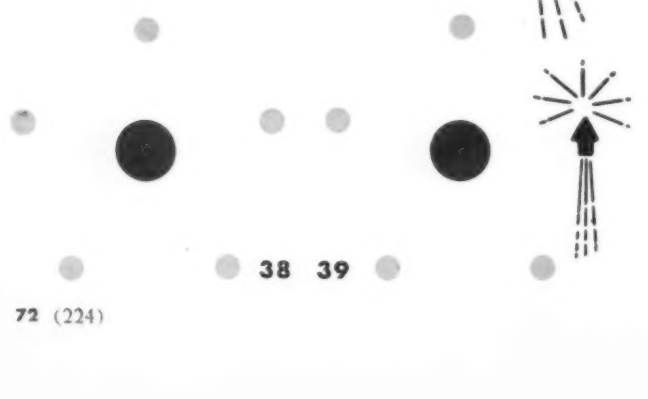


44 Three-element vacuum-tube diagram

41 Three-element high-vacuum tube with direct-heated cathode, a cylindrical metal anode and a spiral wire grid. **42** Symbol of high-vacuum tube with grid control. By adjusting the potential on the grid, current flow through the tube can be controlled from zero to maximum capacity of the tube. **43** Symbol of gas-filled grid-controlled electron tube with indirect-heated cathode. Here the grid prevents the tube firing until the grid is made more positive than a given critical voltage. **44** Simple diagram of a grid-controlled high-vacuum tube with indirect-heated cathode. **45** Symbol of high-vacuum tube with an indirect-heated cathode, a control grid and a screen grid. The screen grid may be similar to the control grid, but it is located



40 Curve indicates how current changes through a three-element high-vacuum tube by adjusting grid potential over a range of 15-v minus to 15-v plus



38 AND 39 GAS ATOM BEFORE AND AFTER BEING HIT BY AN ELECTRON

vacuum tube, and permits more electrons to reach the anode. This action combined with a large increase in free electrons results in a large increase in current flow through the tube compared to a high-vacuum tube under comparable conditions.

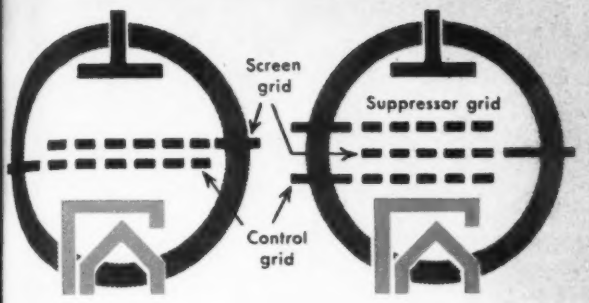
Fig. 36 shows the symbol for a gas-filled tube. It is the same as for the high-vacuum tube, Fig. 34, but contains a large dot, which represents inert gas or a drop of mercury, the latter partially vaporizing when the tube operates.

To control current flow through electron tubes, a third element, known as a grid, is placed between cathode and anode, Fig. 41, and connected to a terminal in the tube base. In other designs, the grid connection is placed in the side of the tube. Grids are made in different forms and materials, Fig. 26 to 28, depending on tube design and size, and its application.

Fig. 42 shows the symbol for a grid-controlled high-vacuum tube with a direct-heated cathode, and Fig. 43 the symbol for a grid-controlled gas-filled tube with an indirect-heated cathode. Fig. 44 shows the simplified circuits for a grid-controlled high-vacuum tube.

Because the grid connects to the minus terminal of its battery, C, it has minus polarity the same as electrons from the cathode. Consequently, the grid opposes electron flow from cathode to anode. Making grid voltage sufficiently minus stops current flow through the tube. Then, moving contact to the right along resistor R reduces the minus potential on the grid and current flow through the tube increases. At zero grid potential, current flow through the tube is practically the same as though the grid did not exist. Making grid polarity plus further increases current flow through the tube.

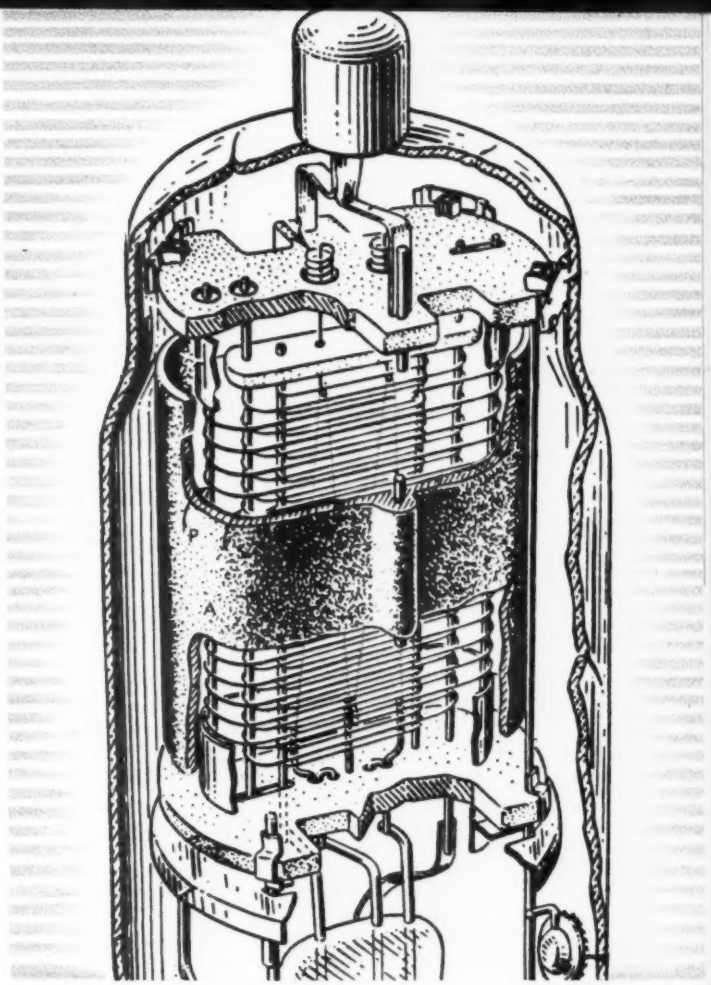
The curve, Fig. 40, indicates how current may vary through a vacuum tube under grid control. Starting with 15-v minus on



45 Symbol for four-element vacuum tube

46 Symbol for five-element vacuum tube

between it and the anode and given same polarity as the anode but of a lower potential. 46 Symbol of a five-element tube with an indirect-heated cathode, a control grid, a screen grid and a suppressor grid. The latter is placed between the screen grid and the anode and is usually connected to the cathode; therefore it has the same polarity



47 Elements in one design of five-element tube. The anode, *A*, connects to a terminal at the top of the tube and the other elements, cathode *C*, control grid *G*, screen grid *S* and suppressor grid *P*, connect to base terminals, not shown. A two-element tube is called a diode, a three-element a triode, a four-element a tetrode, and a five-element tube a pentode

grid, anode current is zero, where anode current at zero grid volts is ten milliamperes. As grid potential increases to 15 v, plus anode current rises to 28 milliamperes. Thus, by varying potential on the grid, tube output can be varied over its entire range. A gas-filled tube under grid control acts somewhat differently from a high-vacuum one, as will be explained later.

A three-element tube has an anode, grid and cathode with insulation (space) between. Accordingly, they form an electrostatic condenser that may interfere with control of tube output. Also, with certain types of loads, voltage drop through the tube may limit its use. To overcome these limitations, a second grid known as a screen grid is added to the tube, making it a four-element unit, called a tetrode, Fig. 45.

When the anode is bombarded by high-velocity electrons from the cathode, the anode may also emit electrons. Known as secondary emission, this has a tendency to retard electron flow from the cathode. In diode and triode, all electrons of secondary emission are attracted back to the anode. Therefore, secondary emission has little effect on the anode current.

In the screen-grid tube (tetrode) if screen potential happens to become higher than that of the anode, the screen attracts secondary emission electrons and seriously affects anode-current flow. In some tubes, to overcome this effect a suppressor grid is placed between screen grid and anode, Fig. 46. Suppressor grid is usually connected to the cathode within the tube to give it a potential that returns secondary electrons to the anode. Such tubes are known as pentodes (five elements).

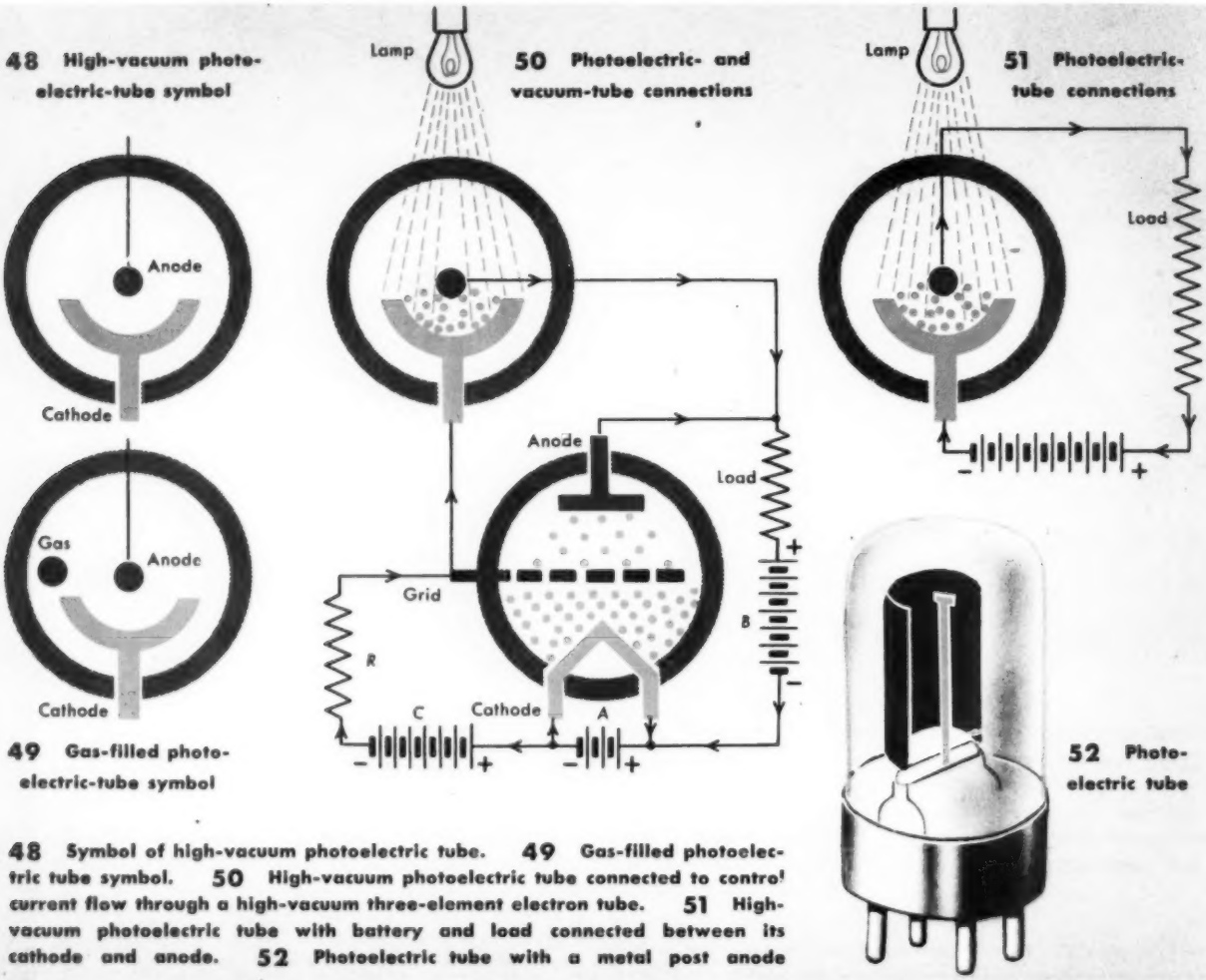
Fig. 47 shows elements arranged in one pentode design, with cathode *C*, control grid *G*, screen grid *S*, suppressor grid *P* and anode *A*. The anode, made of carbon, connects to a terminal in top of tube and the other elements connect to base terminals.

Thermionic tubes described are those most generally used in industry. Frequently they have different trade names, or their purpose may be given a trade name. Some will be considered later. Space does not permit describing other special tubes, such as X-ray, cathode-ray, electron-ray, klystrons, magnetrons and others, but some of them are mentioned in the table on pages 70 and 71.

There are also cold-cathode tubes in which the cathode is not heated, electrons being pulled out of it by sufficiently high voltage from cathode to anode. A glow tube and a radiatron are gas-filled tubes of this type without a grid, where a grid glow tube has a cold cathode and a grid, and is gas filled. Filling tubes with gas at low pressure reduces voltage at which electron discharge occurs between their cathodes and anodes. In some cold-cathode gas-filled tubes, breakdown voltage may be as low as 150.

Photoelectric tubes are another class widely used in industry. They have a light-sensitive cathode and an anode in a high-vacuum, or gas-filled bulb. Cathode is usually semi-cylindrical and anode a straight wire, or wire ring. Photoelectric tube, Fig. 52, has a semi-cylindrical cathode and a straight-wire anode. Cathode is coated with light-sensitive material, such as oxides of cesium, barium, sodium or potassium.

Exposing the light-sensitive material on the cathode to light rays causes it to emit electrons the same as heating the cathode



48 Symbol of high-vacuum photoelectric tube. **49** Gas-filled photoelectric tube symbol. **50** High-vacuum photoelectric tube connected to control current flow through a high-vacuum three-element electron tube. **51** High-vacuum photoelectric tube with battery and load connected between its cathode and anode. **52** Photoelectric tube with a metal post anode

releases electrons in a thermionic tube. Releasing electrons in a photoelectric tube is called photoemission. Fig. 48 shows the symbol for a high-vacuum photoelectric tube, and Fig. 49 the symbol for a gas-filled design.

Filling the tube with inert gas at low pressure increases current flow, particularly at elevated voltages. For example, a vacuum tube may have a current flow of 20 microamperes per lumen of light, reaching its cathode for 10-v potential across anode and cathode. Increasing voltage above this value produces only a small current increase. In a gas-filled tube with 10 v impressed on anode and cathode, current flow is about the same as in the vacuum tube. At 100 v, however, current flow in the gas-filled tube may be about 100 microamperes per lumen, compared to less than 25 microamperes per lumen through a vacuum tube, showing a large increase for gas-filled tubes.

Fig. 51 is an elementary circuit for a photoelectric tube. Here the battery's positive terminal connects to the anode, as for the thermionic tube, Fig. 33. In Fig. 51, as long as light does not impinge on the cathode, the tube acts as an open switch and no current flows in the circuit. When light hits the cathode, as shown, electrons are released and the tube becomes a conductor.

Current now flows from anode through load and battery to cathode and back to anode, as indicated by arrows, and continues to flow as long as light shines on the cathode. Remove the light and current ceases to flow. Thus, the simple process of interrupting a light beam may start and stop electric-current flow in a circuit.

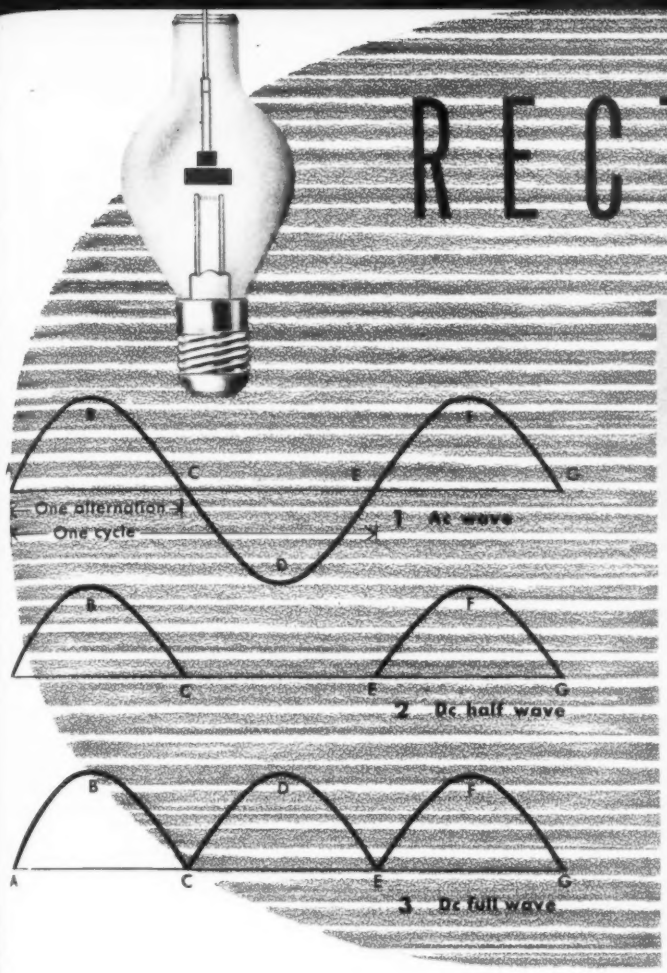
Fig. 50 shows one way that a photoelectric tube may control output of a grid-controlled vacuum tube. Battery C through resistance R connects to the vacuum tube's grid and to the phototube's cathode. If the light beam is interrupted, current flow through the tube stops and battery C's full voltage is applied to the grid, giving it a minus potential. Being minus, the grid opposes electron flow from the cathode and reduces current through the tube, or stops it entirely, depending on the minus potential on the grid. When the light beam hits the phototube cathode, current flows from battery C, the phototube, the load, batteries B and A, and back to battery C.

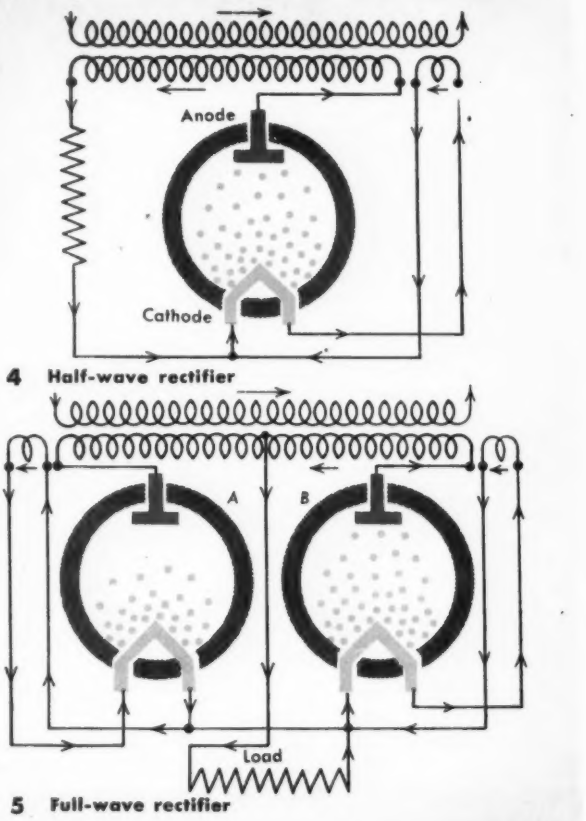
Because of voltage drop through resistance R, minus potential on the grid decreases, and current flow through its tube increases. Here, simply by making and breaking a light beam, current flow is controlled through the load on a thermionic tube.

The foregoing gives a general idea of some of the more common forms of electronic tubes and their simple circuits. Later, in other articles we will study the applications of some of these tubes and their circuits.

In preparing this article, the author received valuable assistance from the books mentioned on page 65, the tube manuals of RCA Mfg Co, and the electron-tube publications of General Electric Co and Westinghouse Electric & Mfg Co.

RECTIFIERS





1 Curve representing alternating current, or voltage. 2 Direct-current flow from half-wave rectification of ac. 3 Direct-current flow from full-wave rectification. 4 High-vacuum electron tube connected for half-wave rectification. 5 Two high-vacuum electron tubes connected for full-wave rectification

ALL electron tubes act as check valves in a circuit; that is, they permit current to flow through them in only one direction from cathode to anode, as explained in the preceding article. This characteristic makes it possible to use them to convert (rectify) alternating into direct current.

In Fig. 1, a curve represents an alternating voltage, or current. Starting at *A* where current is zero, it rises to a maximum value at *B* and decreases to zero again at C. On the next wave, the current reverses its direction of flow in the circuit to reach maximum value at D, and returns to zero at *E*.

Fig. 4 shows a simple electron-tube rectifier. Assume that curve *ABC*, Fig. 1, represents the voltage applied to the primary of the transformer in the direction of the arrow, Fig. 4. A small section of the transformer's winding provides heating current for the cathode. When the cathode is heated to the proper temperature, it emits electrons toward the anode.

At the instant we are considering, transformer-secondary polarity is such as to make the anode plus and current flow through the load and tube as indicated. Current then flows through the tube during the voltage wave *ABC*, Fig. 1, and may be represented by wave *ABC*, Fig. 2.

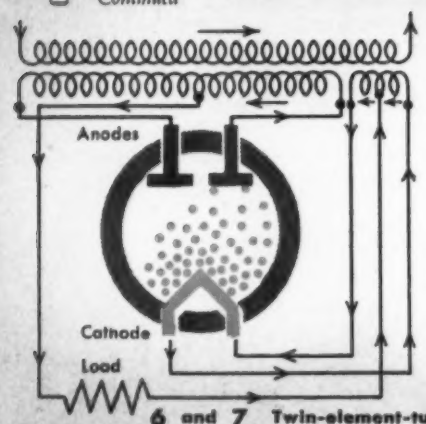
During alternation *CDE*, voltage on the transformer is reversed, which gives the anode a minus polarity. Then, instead of attracting electrons, Fig. 4, it repels them and current cannot flow through the tube. Therefore, during the ac wave, *CDE*, no current flows in the dc circuit as during the period *CE*, Fig. 2. During the next ac wave, *EFG*, conditions are the same as *ABC*, Fig. 1, and current again flows in the dc circuit, as represented by wave *EFG*, Fig. 2. Thus, the tube lets current of each half cycle flow in the dc circuit. This is known as half-wave rectification and is used to rectify small power.

To rectify both halves of the cycle, two tubes are connected as in Fig. 5. Small sections of the transformer secondary winding connect to the cathodes to heat them. With the transformer polarity, Fig. 5, tube-*A* anode has minus polarity and current cannot flow through it. Anode of tube *B* has plus polarity and it conducts current from cathode to anode and through its external load, as indicated. Assume the operation to be during period *ABC*, as in Fig. 3.

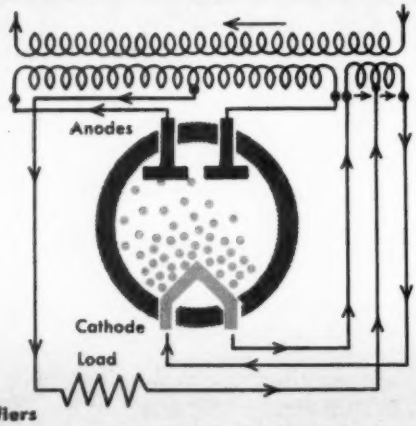
During period *CDE*, Fig. 1, transformer voltage reverses and gives tube-*B* anode minus polarity so that current cannot flow through it. Tube-*A* anode has plus polarity and passes current in the same direction through the load, as during the first alternation. In this way, *CDE* half of the ac cycle is active, but in the same direction as *ABC*, as in Fig. 3. The load current thus flows in a series of waves in the same direction, known as full-wave rectification. In some cases where small power full-wave rectification is required double-element tubes are used, Fig. 8 and 9.

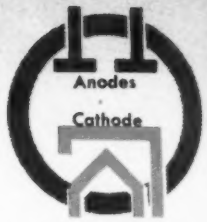
Fig. 6 gives the simple rectifier connections for a twin-anode tube and indicates current flow in the circuit for one wave of operation. The load taps to the center of the cathode-heater section of transformer winding. This is to give the same voltage in

6 and 7 Full-wave rectification of ac to dc with a high-vacuum tube. **8** Twin-element high-vacuum tube with indirect-heated cathode and two anodes. **9** Twin-element tube with two cathodes



6 and 7 Twin-element-tube rectifiers





8 and 9 Twin-element tubes

each wave of rectified current. At the instant represented in Fig. 6, load current flows from the center tap to the left in the cathode-heater section of the transformer. On the next wave of rectification the current will be reversed in the transformer and the load current will flow through from the center tap to the right in the cathode heater section of the transformer winding, as in Fig. 7.

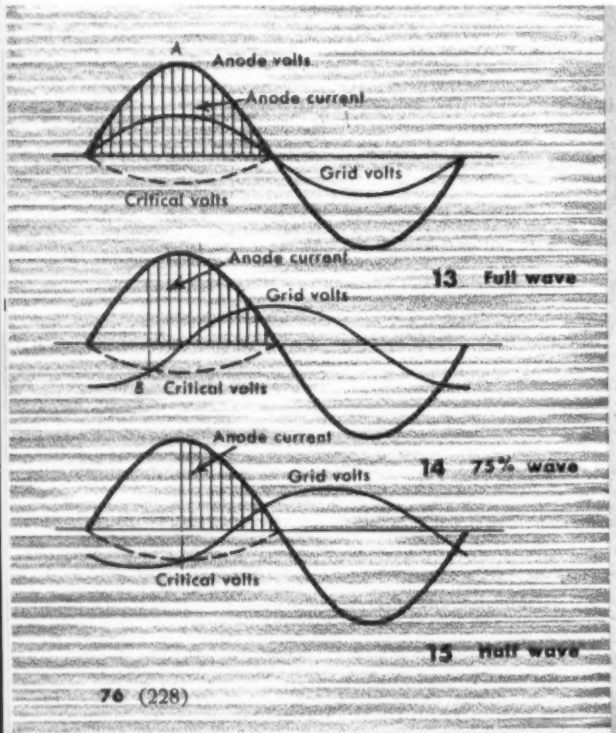
In both cases, one-half of the heater section of the transformer winding is in series with the main section of the winding supplying the load and of the same polarity. As a result, the voltage applied to the load is the same for each half cycle. This would not be true if the load connected to one side of cathode only. Then during one-half cycle of rectification the cathode-heater section of the transformer winding would be in series with the load circuit, and on the other half-wave the load circuit would go directly to to the cathode.

This also explains why, in Fig. 5, it was necessary to connect the cathode of each tube to a separate section of transformer winding. When tubes with indirect-heated cathodes are used, both heaters can be connected to the same section of transformer and one side of the load to both cathodes.

Charging storage batteries is one of the extensive uses of medium-sized electron tubes. Some of them, used for currents up to 20 amperes, may contain both argon and mercury, or only mercury. They have carbon anodes of two general designs: 15-amp size, Fig. 10, and 5-amp size, Fig. 11. Fig. 12 shows elementary diagram of a two-element gas-filled tube connected to charge a battery from an auto-transformer. A reactor in the charging circuit smooths out the pulsating current flow to the battery. Taps on the left-hand end of the transformer permit using the charger on 105- 115- or 125-v ac circuits.

Assume that current flows in on line *B* and out on line *A*, and that the cathode has been heated. The primary circuit of the transformer is then from *B* to the cathode and anode, through the battery, into the transformer winding at *C* and out at *A*, as arrowheads indicate. Current flowing in the transformer primary induces a voltage in the secondary section opposite to that in the primary, shown by the arrow pointing from *C* toward *B*. Secondary winding from *D* to *B* supplies cathode heating current. Part of the current to charge the battery comes from the secondary winding, the circuit being from *C* to *B*, through the tube and battery back to *C*. This is a half wave rectifier, as explained for Fig. 4.

The thyratron, a hot-cathode tube, contains a large drop of mercury that partially vaporizes to gas. Gas pressure in the tube corresponds to the vapor pressure of the mercury at a given tem-

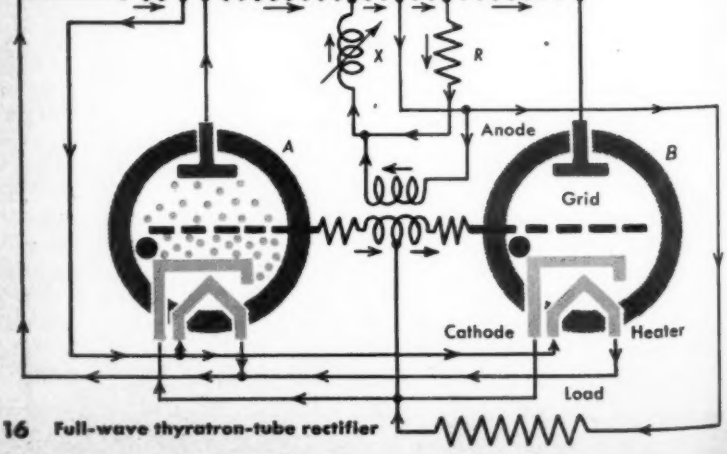


13 Full wave

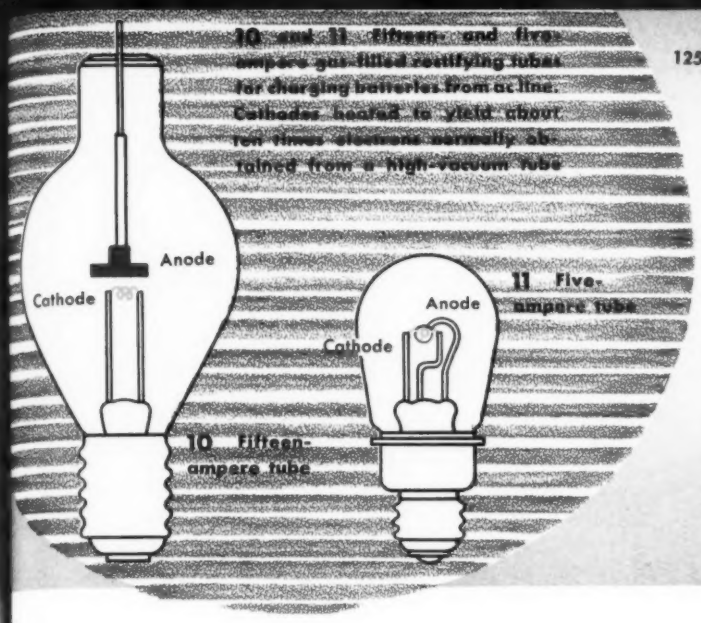
14 75% wave

15 Half wave

13 to 15 Shaded areas on the curves indicate the time during which a thyratron tube conducts. **16** Two thyratron tubes with phase shift of grid potential to control output, connected for full-wave rectification



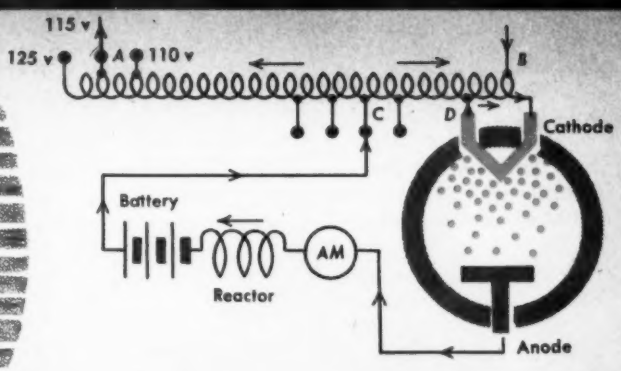
16 Full-wave thyratron-tube rectifier



10 and 11 fifteen- and five-ampere gas-filled rectifying tubes for charging batteries from ac line. Cathodes heated to yield about ten times electronic normally obtained from a high-vacuum tube

10 Fifteen-ampere tube

11 Five-ampere tube



12 Elementary diagram of a two-element gas-filled tube, connected to charge a small storage battery from an auto-transformer. A reactor in the battery-charging circuit smooths out the half-wave direct-current flow

perature. For best operation, the tube's temperature should be kept within certain limits.

By changing the potential on the grid of a high-vacuum tube, its output can be regulated from zero to maximum. In a thyratron the grid can prevent the tube from passing current, but after the current starts to flow it no longer has control. The grid can get control again only when the current passes through zero, as in an ac circuit.

When an ac voltage, like *A*, Fig. 13, is applied across a thyratron tube in a direction to make the anode positive, and the grid is maintained negative above a critical voltage, the tube will not conduct current. This critical negative voltage is indicated by the dotted curve. As long as the grid remains negative at a voltage above the critical the tube acts like an open switch in the circuit.

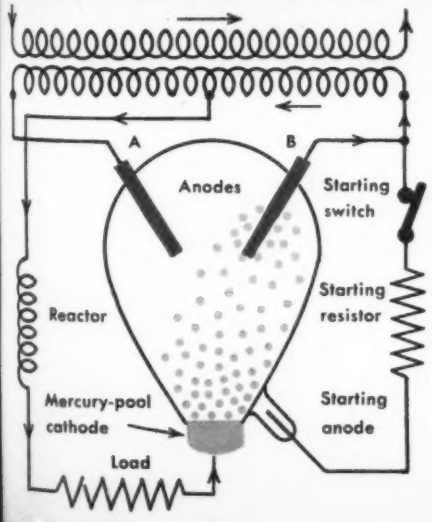
If the grid voltage is positive and in phase with a positive anode voltage, as in Fig. 13, the tube will conduct current during the entire voltage wave, indicated by shaded area. Anode current is controlled by shifting the grid voltage out of phase with the anode voltage, as in Fig. 14. Here the grid voltage going toward positive crosses the critical voltage curve at *B*. This makes the grid less negative than the critical value and the tube begins to conduct current and does so for the remainder of the voltage wave, shown by the shaded area.

If the grid voltage is shifted out of phase so that it crosses the grid critical voltage curve at its maximum value, Fig. 15, then the tube conducts current only during the last half of the anode-voltage curve. If the grid voltage curve is shifted more out of phase with the anode voltage, the tube conducts current for a still smaller part of the voltage wave. By the simple expedient of changing the phase relation between grid and anode voltages, the tube's output current can be controlled from zero to maximum.

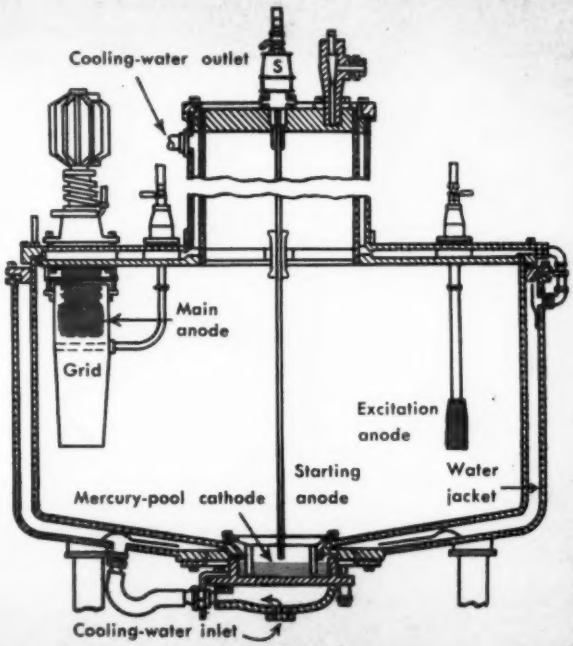
Grid voltage can be shifted by connecting a fixed resistance, *R*, and an adjustable inductance, *X*, in series and connecting them to a center section of the power transformer secondary, as in Fig. 16. When the left-hand terminal of the transformer is positive, the grid of tube *A* will have positive potential and this tube will conduct. The operation of this rectifier is the same as that of Fig. 5, except for the grid control.

Another group of electron tubes fall in the class known as mercury-arc rectifiers. Instead of having a hot cathode as in thyratrons and other types of tubes we have previously considered, a mercury-arc rectifier has a mercury-pool cathode, Fig. 17. During operation of the rectifier one or more hot spots develop

17 Instead of a hot cathode, as in thyratrons, this mercury-arc rectifier has a mercury-pool cathode. During operation, hot spots develop on mercury-pool cathode from which electrons are emitted



18 Cross-section through a large water-cooled mercury-arc rectifier, showing one of its six or twelve main electrodes, the starting anode and one of its two excitation anodes. They are small and placed closer to the cathodes than the main anodes



RECTIFIERS
Concluded

on the surface of the pool from which free electrons are emitted, but means must be provided to initiate emission of electrons. One method of starting, used with the old glass-tube rectifier, Fig. 17, tips the tube until mercury flows from the pool to the starting anode. A current then flows from the center of the transformer through the load, mercury pool, starting resistance, and to the right-hand terminal of the transformer.

Returning the tube to the vertical strikes an arc between the starting anode and the mercury pool. Electrons are emitted and current flows from the cathode to main anode *B*, as indicated. The tube is now in service and the starting switch can be opened. When line voltage reverses on the transformer, the left-hand section of its secondary becomes active, with anode *A* in the dc circuit.

Until recently, large mercury-arc rectifiers were contained in water-cooled steel tanks, Fig. 18, with as many as 18 anodes in a single tank. Power taken from a three-phase supply is converted into as many phases as anodes in the rectifier by the step-down transformer. To start this rectifier, its starting circuit is closed, which first energizes solenoid *S* on the starting anode to pull it down into the mercury cathode, against the tension of a spring. Deenergizing solenoid *S* permits the starting anode to return to its normal position.

When the starting anode pulls out of the mercury a hot spot forms that emits free electrons. These electrons flow to the excitation anodes because of their positive potential. Since these anodes have a closed circuit for current flow they start operating. After they establish operating conditions within the rectifier, the main power electrodes pick up the load as soon as their circuit breaker closes. Rectifiers of this design can have their voltages regulated by a grid below their anode in much the same way as in a thyratron.

To eliminate some of the operating difficulties with multi-anode rectifiers and to increase their efficiency, particularly at voltage below 300, single-anode rectifiers have come into general use. One of these, the excitron, Fig. 19, has a single water-cooled tank in which are the main anode, control grid, two excitation anodes, a starting anode and the mercury-pool cathode. These units are assembled in groups of 2, 3, 4, 6 or 12 for single-phase, three-phase, four-phase, six-phase or twelve-phase rectification on the same principle used in multi-anode rectifiers.

This rectifier is started by an ignition coil *C* that operates a plunger below the mercury-pool cathode. Energizing the ignition coil pulls the plunger downward and it throws a jet of mercury up against the starting anode. When the mercury jet collapses an arc forms which is instantly transferred to the excitation anodes to maintain the rectifier ready for operation of the main anode.

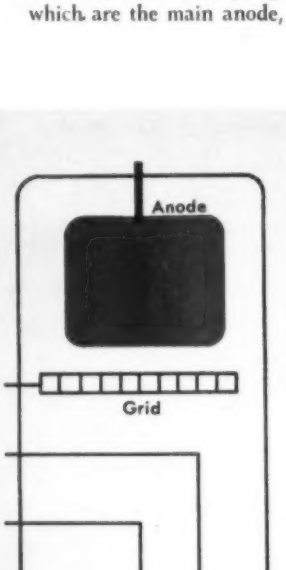
Another design of single-tank rectifier is known as the ignitron, Fig. 20. In this design each rectifier tank is ignited every other ac wave and is extinguished at the end of each rectification period. This is done by an igniter, consisting of a small piece of crystal dipping into the mercury pool. It may be thought of as performing the same function as a spark plug in a gasoline engine. There are many ways of firing the igniter, but the use of a thyratron, connected as in Fig. 20, demonstrates the principle.

Assume a transformer polarity as indicated by the arrows. This makes the anode and grid of thyratron $\mathcal{T}$ positive and its cathode negative. As potential increases across $\mathcal{T}$, it will conduct current because its grid is positive. This circuit is from the midpoint of the transformer through the load, mercury pool to igniter of rectifier $\mathcal{R}$, tube $\mathcal{T}$, and back to the righthand terminal of the transformer.

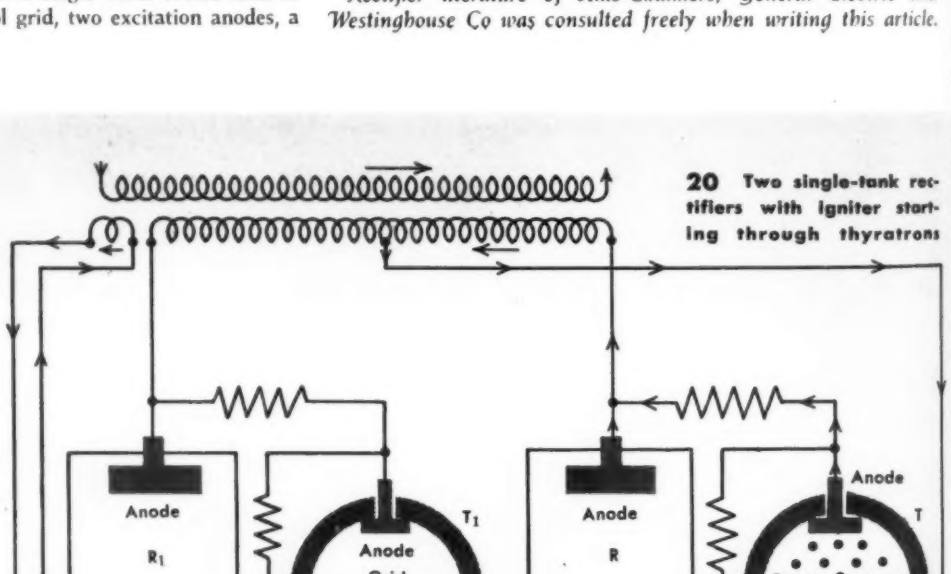
Current passing from mercury pool to the igniter causes the pool to spark, creating a cathode hot spot, from which free electrons emit; current then flows from cathode to anode. As soon as the main anode begins to carry current, voltage drop from it to the cathode becomes so low that current ceases to flow through thyratron $\mathcal{T}$ and igniter circuit, and they stop functioning.

On the other half of the ac cycle, thyratron $\mathcal{T}_1$ and rectifier $\mathcal{R}_1$ come into operation in the same way as explained for $\mathcal{R}$ and $\mathcal{T}$. Ignitron output voltage can be controlled by producing a phase-shift between the grid and anode voltage of the thyratron, as in Fig. 13 to 16. This delays operation of the thyratron which, in turn, delays firing of the igniter.

Rectifier literature of Allis-Chalmers, General Electric and Westinghouse Co was consulted freely when writing this article.



19 Single-tank mercury-arc rectifier

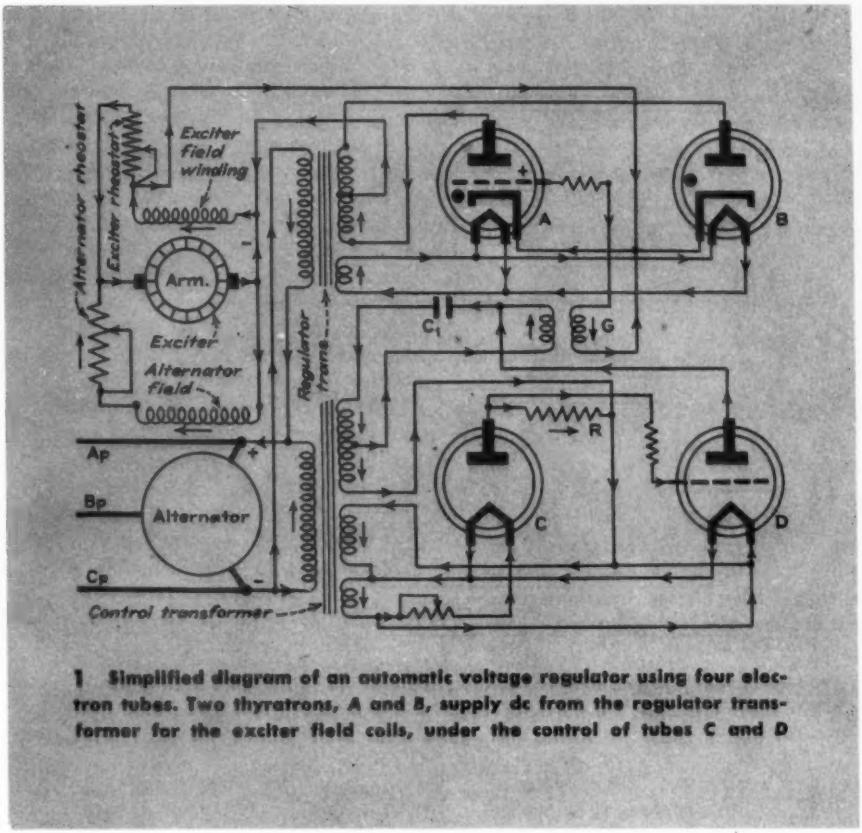


20 Two single-tank rectifiers with igniter starting through thyratrons

VOLTAGE REGULATORS

ELECTRON-TUBE automatic voltage regulators have been developed in several forms. Some that are quite simple use only one tube; others that are more complicated require several tubes, depending on the duty for which the regulator is designed. Because electron tubes have no time lag in their operation and require such small control power, these regulators have high sensitivity and speed of response.

Fig. 1 shows a simplified diagram of a Ward Leonard Electric Co voltage regulator, which uses four electron tubes. Thyratron tubes *A* and *B* supply the field current to the exciter from the regulator transformer. Control transformer energizes grid transformer *G*, the potential of which is controlled by tubes *C* and *D*. Assume phase A_pC_p of the alternator has the instantaneous polarity indicated. Then current can flow from the middle tap of the regulator transformer through the exciter field winding, tube *A*, and the bottom half of the transformer secondary winding, as indicated. On reverse polarity of the transformer the top half of its secondary winding and tube *B* become active to supply a rectified current to the exciter field winding.



1 Simplified diagram of an automatic voltage regulator using four electron tubes. Two thyratrons, *A* and *B*, supply dc from the regulator transformer for the exciter field coils, under the control of tubes *C* and *D*

Control potential on tube *A* grid comes from grid transformer *G*, regulated by tubes C and D. These tubes and grid transformer *G* connect to the control transformer. Bottom section of this transformer heats tubes *C* and *D* cathodes. Middle section of the control-transformer's secondary supplies current through tube *C* and resistance *R*, as indicated. Voltage drop across resistance *R* applies a minus potential to tube-*D* grid.

Assume that the alternator's voltage increases, as it does when its load decreases. Then, voltage on the control transformer rises and increases current flow through tube *C* and resistance *R*. This increases the voltage drop across *R* and increases the minus potential on tube *D* grid to reduce current flow through this tube.

Tube *D* and condenser C_1 connect to form the two legs of a phase shifter for grid transformer *G*. Then, reducing the current through tube *D* has the same effect as increasing the resistance in this leg of the phase shifter. This causes a phase shift of tube *A* grid potential that delays firing of this tube to reduce the exciter field current and restore the alternator's voltage to normal.

When the alternator's voltage decreases, as when it picks up load, potential on tube *D* grid decreases and causes a phase shift of tube *A* grid potential, which permits an earlier firing of this tube to increase the exciter voltage and restore the alternator's voltage to normal. Thus, the regulator automatically holds the alternator's voltage to within $\pm$ 1% of normal.

When the alternator's polarity reverses, all tubes become inactive with the exception of tube *B* and it supplies the exciter's field current from the top half of the regulator transformer. It is necessary to control voltage of only one thyratron to change current input to the exciter field coils from both tubes. The exciter field winding is highly inductive and is the common load of both tubes. With such a load the tubes become electromagnetically coupled.

Current flow through a two-element high-vacuum tube depends on its cathode's temperature and the voltage applied from cathode to anode. Raising voltage of cathode increases its temperature and current flow through the tube. A similar result is obtained by increasing voltage from cathode to anode. Raising voltage from cathode to anode and across cathode simultaneously produces a proportionately greater current flow through the tube. This is the condition under which tube *C* operates. A change in generator voltage changes the potential across the cathode and from it to anode. This effect, combined with operation of the tube within its saturation-curve sensitive range, makes the regulator respond to very small generator-voltage changes.

These regulators may be used with a line-drop compensation to maintain a constant voltage at a power-distributing center. Where unbalanced voltages exist, generator voltage can be regulated by connecting controlling tube-*C* cathode to an average of the three-phase voltages. Electron-tube automatic voltage regulators may be used to control generators operating in parallel, and under certain conditions a single regulator can control two or more generators.

With electronic voltage regulators, field forcing is made possible by the regulator's ability to quickly deliver a voltage across the exciter shunt field coils in excess of exciter armature voltage. These regulators provide over-voltage protection and abnormal voltage cannot be impressed on the exciter field winding while its regulator is in operation. On small generators, the exciter may be omitted and the rectifying tubes used to supply exciting current direct to the alternator's field coils after initial excitation has been provided. Such applications have been made and indicate the wide range of possibilities of these regulators applied to ac generators.

DC-MOTOR SPEED CONTROL

BECAUSE simple methods can adjust speed and torque of dc motors over wide ranges, much attention has been given to their applications where only ac power is available. When speed range of 4 to 1, or less, is sufficient, ac is converted to dc, and dc-motor speed is controlled by a simple rheostat in its shunt-field-winding circuit. Greater speed ranges generally require a variable-voltage system of control with a motor-generator set for each dc motor. The latter provides both armature voltage and field-current control to give almost any desired speed range. Electron-tube systems of ac-to-dc conversion and dc-motor speed control have been developed that provide torque and speed regulation not possible by other means. These systems are available in several arrangements to meet the requirements of a wide range of applications.

Fig. 1, a diagram of one of the simplest of these systems, combines ac-to-dc conversion with a standard dc-motor starter and speed control by a field rheostat. Ac-to-dc conversion is by two thyratron tubes, D and E. As they require about five minutes to heat and become operative, the control has a time delay to prevent the motor starting before the tubes are ready to take load. Here is how it works:

When the line switch is closed, contacts A remain open to disconnect the thyratrons D and E from the line. Cathode heaters are energized from filament transformer T_2, current direction being instantly indicated by arrowheads. Coil TDR of the time-delay relay is also energized to start timing out. After five minutes this relay closes its contact, TDR, which energizes coil A of anode contactor A, and it closes. When contact TDR closed, contact TD on the time-delay relay opened and stopped this relay.

Closing contacts A puts potential on the thyratrons and on the motor controller. Then, closing the start button completes a circuit through accelerating contactor coil C, from center tap of the power transformer through this coil, contact L_1, the start button, thyratron E, to the transformer. Coil C opens contact C_1, across armature starting resistor R_s, and closes contact C_2. The latter completes a circuit for coil L to close motor energizing contactor L.

When L closes, it also closes contact L_2 in series with coil L to provide a holding circuit around the start button, so that it can be released and this coil remain energized. Closing contactor L opens contact L_1, to deenergize coil C, thus releasing its contact, C_1. This contact has a time delay so that it does not close until the armature has partly accelerated.

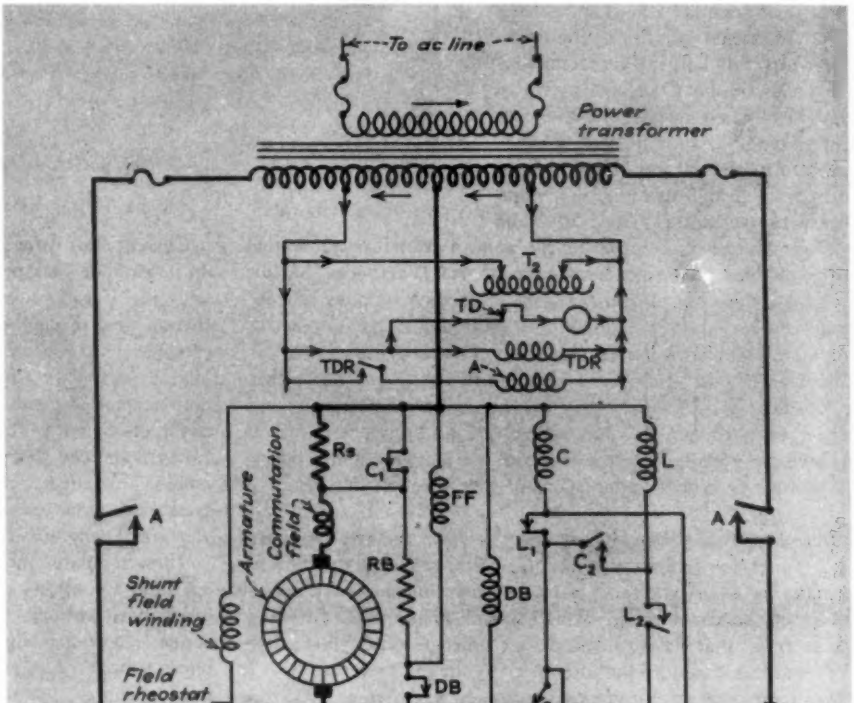
Simultaneously with closing of armature circuit by contact L, dynamic-braking coil DB and field-forcing relay coil FF were energized. Coil DB opened contacts DB to break the dynamic-braking circuit across the armature. A circuit for coil FF is retained from transformer center tap through coil, dynamic-braking resistor RB, armature, contact L, and thyratron E to the transformer.

Coil FF closes contact FF to shunt the field rheostat out of circuit and put full voltage across the shunt-field winding during armature acceleration. As the armature accelerates, contact C_1 closes and cuts out starting resistance R_s. Voltage then drops across coil FF to where its contact FF opens and puts the rheostat in series with the shunt-field winding. After which, the motor comes up to a speed determined by the field-rheostat setting. Speed can then be adjusted above base value by the field rheostat, the amount of adjustment depending on motor design and the ohmic resistance of the rheostat.

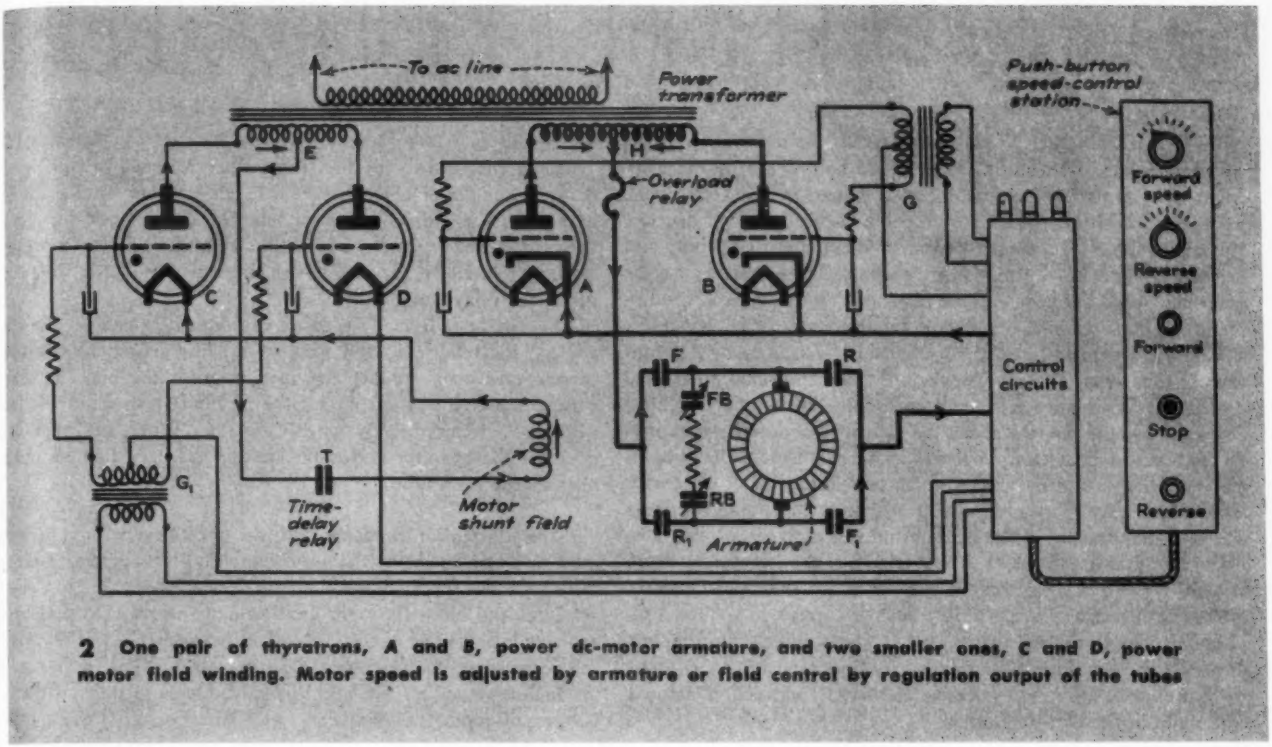
Pressing the stop button opens coil L circuit, and its main contactor, L, opens to stop the motor. Opening main contact L breaks the circuit through coil DB, and contact DB closes to connect the dynamic-braking resistor across the armature, thus slowing it down quickly.

A jog button is provided in the pushbutton station. When the motor is started from this button it runs only as long as the button is held closed. Once the thyratrons are energized they remain so, ready to supply power to the motor until the line switch is opened.

In Fig. 1, the whole function of the thyratrons is to supply direct current to a standard dc motor, whose speed is adjusted by a shunt-field rheostat. Next step is to use the thyratrons for starting the



1 One of simplest applications of electron tubes to dc-motor speed control; two thyratrons, D and E, supply power to a dc motor from an ac system and motor speed is adjusted by rheostat in shunt-field circuit



2 One pair of thyratrons, A and B, power dc-motor armature, and two smaller ones, C and D, power motor field winding. Motor speed is adjusted by armature or field control by regulation output of the tubes

motor and regulating its speed, in addition to supplying dc power for its operation. Fig. 2 shows a simplified diagram of such a control. Most of the speed control and time-delay circuits are combined in the control-circuit and speed-control cabinets. To simplify the diagram they are not shown in detail.

In Fig. 2, one pair of thyratrons, A and B, power the armature and two smaller ones, C and D, power the motor shunt-field winding. The armature circuit also has reversing contacts so that the motor may be operated in either direction of rotation. Speed control of the motor is by some form of phase-shifting device in the armature and in the field circuits to adjust voltage. These phase-shifting devices act on grid transformers G and G_1, with the effect explained in Fig. 13 to 16, page 76. Grids of tubes A and B connect to transformer G, and those of tubes C and D go to transformer G_1. Primary of these transformers goes to the phase-shifting device in the control-circuit and pushbutton assemblies.

In the pushbutton speed-control station there are two potentiometers, one for forward and one for reverse direction of motor speed. They may be preset for any forward and reverse speeds. Then when either a forward or reverse pushbutton is pressed, motor automatically comes up to preset speed. If it is below base speed of the motor, thyratrons C and D apply full voltage to the shunt-field winding, and thyratrons A and B gradually increase their output voltage to a value that gives preset speed.

If preset speed is above base speed, thyratrons C and D apply full voltage to the field coils, and A and B gradually increase their output voltage to accelerate the armature to its base speed. Then, thyratrons C and D reduce shunt-field winding voltage to accelerate the motor to preset speed. After motor is thus accelerated, it can be adjusted to any other speed within the equipment's range simply by moving the speed control to the desired point.

Normal speed range by armature control is 20 to 1 below the motor's base speed, though a much wider over-all range, such as 100 to 1, can be obtained. Field control is normally 2 or 3 to 1, but top speed is limited by the motor's electrical and mechanical limitations.

In Fig. 2, assume that the equipment has been connected to the line for at least five minutes. By that time, the thyratrons will have been heated to operating condition, and time-delay relay will have closed contact $\mathcal{T}$ in the field circuit. Assume forward button has been pushed and transformer polarity is as shown. Then the field circuit is from tap $\mathcal{E}$ through the field winding and tube C to transformer's left-hand terminal. On reverse polarity of transformer, current still flows from tap $\mathcal{E}$ through the field winding and tube D to the right-hand terminal of transformer, full voltage being applied to the field winding for starting.

In the armature, forward direction contacts $\mathcal{F}$ and $\mathcal{F}_1$ close, and dynamic-braking contact $\mathcal{FB}$ opens. This provides a circuit from transformer tap $\mathcal{H}$ through contact $\mathcal{F}$, the armature, contact $\mathcal{F}_1$, and the control circuit's tube A, to left-hand transformer terminal. On reverse polarity of the transformer, circuit is the same as described, but tube B and the transformer's right-hand section come into operation. Motor accelerates to the speed preset in the control and operates at this speed until some change is made in the control setting.

Assume that the reverse button is pressed. Forward contactors $\mathcal{F}$ and $\mathcal{F}_1$ open and dynamic-braking contact $\mathcal{FB}$ closes to slow the motor to standstill quickly, when reverse contacts $\mathcal{R}$ and $\mathcal{R}_1$ close and dynamic-braking contact $\mathcal{RB}$ opens. If the motor in forward direction was operating above base speed, field-coil voltage returns to normal so that motor accelerates with full field when reverse contacts close. Motor then accelerates to a speed determined by setting of the reverse speed control.

Standard electronic control automatically regulates motor speed to maintain it practically constant at any setting, regardless of load. In a properly adjusted system, speed over 10-to-1 range does not vary more than 4% from preset value when torque varies from no load to full load. For any setting within a range of 20 to 1, the speed does not change more than 8%. Normal ac-line-voltage variations have only small effect on motor speed regulation. The system operates successfully when rated voltage varies 10%.

Those who wish to study the subject further will be interested in the literature of General Electric Co and Westinghouse Electric & Mfg Co, also a series of five articles, "Electronic Control of DC Motors," by E E Moyer, in Electronics, *May to Oct., 1943.*

FLAME-FAILURE PROTECTION

ALTHOUGH MARKETED under several names, all electronic flame-failure safeguards are designed to prevent the development of explosion hazards in furnaces fired by pulverized coal, oil or gas. If the flame fails or other unsafe conditions develop, this equipment, in its simplest form, shuts off the fuel supply and attracts the operator's attention by a signal. These systems may be modified by addition of various interlocks, furnace purges, automatic ignition, relights, timers, alarms and many other devices.

Operation depends on detecting a flame's existence by a photoelectric tube or an electrode, or both. Furnaces burning pulverized coal or oil, in which flame luminosity is light yellow, or brighter, generally use the photoelectric-tube detector. Ordinarily it cannot be applied to a blue flame, such as gas burners make. They use an electrode detector in the flame, which is a conductor of electricity with a resistance of from 1 to 100 megohms depending on flame size and shape, type of combustion and direction of current flow.

Current that is carried by a photoelectric tube exposed to flame luminosity, or by an electrode in the flame, is too small to operate fuel valves or relays. Accordingly such a current is amplified by vacuum tubes to desired values. Fig. 1 shows one of the simplest forms of flame-failure safeguards, a system used on an oil-fired furnace, with pushbutton opening of the fuel valve and manual lighting of the flame with a torch.

The diagram shows no-flame conditions, when, for example, the flameguard has been energized but the fuel valve is still closed. Assume transformer instantaneous polarity, as shown. Secondary S_1 supplies current to heat the cathodes of the twin vacuum tube T. Transformer secondaries S_2 and S_3 complete a circuit from cathode C to anode A, secondary S_3, resistor R_1, and secondary S_2. Until there is a flame, photoelectric tube P is inactive and there is no potential on grid G, consequently current can flow between cathode C and anode A.

Voltage drop across resistor R_1 puts minus potential on grid G_1. How this potential is produced can be easily seen by considering secondary S_3 alone. If a connection were made between grid G_1 and cathode C_1 current from S_3 would flow from grid G_1 to cathode C_1, then from C to A, and back to S_3. In the absence of the connection between G_1 and C_1, there exists a minus potential equal to that of secondary S_3, and this side of the tube cannot conduct. As a result the relay coil remains dead, a circuit for this coil being through secondary S_2, cathode C_1, anode A_1, secondary S_4 and back to the relay, but it is blocked by grid G_1. Relay contacts, therefore, remain closed in the position shown, and the pilot light is energized through contact L_1 to show a no-flame condition.

Closing the pushbutton connects the fuel-valve-opening coil across the line. This valve opens and when the fuel is burning with sufficient flame the photoelectric tube conducts on the reverse transformer polarity from that in the diagram. This circuit is from terminal N of secondary S_2, the relay coil, resistor R_2 to ground through the photoelectric tube, resistors R_3 and R_4, back to S_2. Anode of the photoelectric tube connects between R_3 and R_5, which puts a minus potential on grid G equal to the voltage drop across R_3 and R_4, and charges the condenser D.

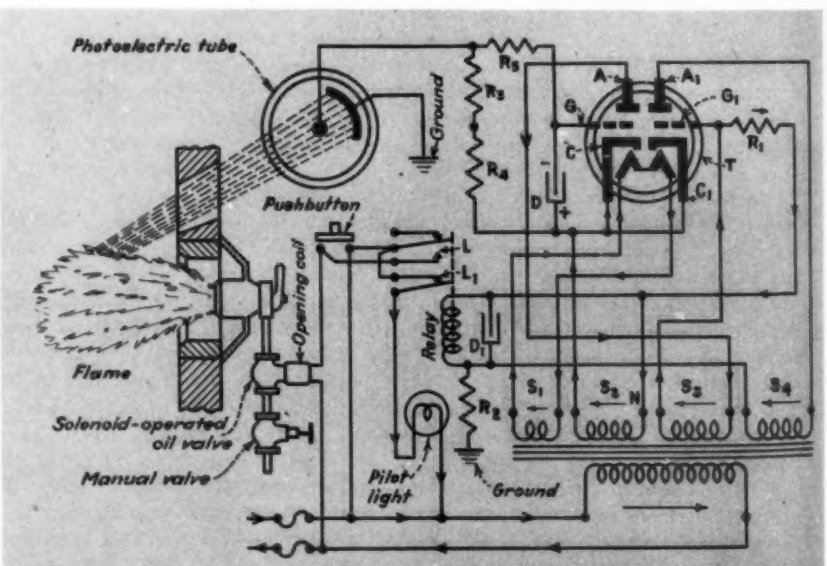
When the polarity of the transformer reverses to that in the diagram condenser D discharges through resistors R_5, R_3 and R_4, and maintains minus potential on grid G to block the circuit between cathode C and anode A. Blocking this circuit removes the minus potential on G_1 and the right-hand side of the tube completes the relay-coil circuit.

This circuit is from S_2 through cathode C_1, anode A_1, secondary S_4, the relay coil, and back to S_2. Energizing the relay coil causes it to open contact L_1, to extinguish the pilot light and close contact L, to short circuit the pushbutton and put the fuel-valve coil circuit directly across the line. When the pilot light goes out the operator knows the burner has been lighted and he releases the pushbutton.

If for any reason the flame fails, the photoelectric tube becomes inoperative and removes the minus potential from grid G. Current can again flow from cathode C to anode A to give grid G_1 a minus potential and block the right-hand side of this tube, as previously explained. Since the circuit is blocked between C_1 and A_1, relay coil deenergizes, to open contact L and close L_1. The former opens the fuel-valve-coil circuit, and this valve closes to shut off the oil. Closing of contact L_1 lights the pilot lamp to signal the operator that the fire is out.

To prevent the relay dropping out during transient flame disturbances, such as puffs and flickering, that temporarily shut light off from the photoelectric tube, a condenser D_1 connects across the relay coil. Time delay in relay opening after its coil circuit is blocked depends on the size of the condenser and the charge on it just before flame interruption. This time can be adjusted but if insufficient to overcome effects of transient flame disturbances, it may be lengthened by increasing condenser capacity.

Fig. 2, a gas-burning system, includes a flame-electrode, main



1 Simple form of flame-failure-protection system for an oil-fired furnace uses a photoelectric tube for flame watching and twin high-vacuum electron tube with grid control for amplification. A pushbutton opens solenoid-operated fuel valve and operator lights off manually with torch

gas burner, pilot burner and automatic ignition. The control part of the system uses two twin vacuum tubes $\mathcal{T}$ and $\mathcal{T}_1$. Assúme no-flame conditions with the line switch closed. Cathodes of the two tubes are heated and the pilot light energized from transformer secondary S_3, as indicated by the arrowheads. Secondary S_1 completes a circuit through resistor $\mathcal{R}_1$, cathode C_1 and anode A_1 of tube $\mathcal{T}$, back to S_1. Under this condition grid G does not have a minus potential and this side of the tube conducts when the polarity of secondary S_2 is the reverse of that shown. This circuit is from terminal M of secondary S_2 to cathode C, anode A, through resistor $\mathcal{R}_4$, back to S_2. Voltage drop across $\mathcal{R}_4$ puts a minus potential on the grids of tube $\mathcal{T}_1$ to block the relay-coil circuit. This circuit, when not blocked, is from terminal N of secondary S_4 through the relay coil, secondary S_2, cathodes C_2, anodes A_2, back to S_4.

Closing the start button completes a circuit from the line through the ignition coil, contact $\mathcal{L}_1$, start and stop buttons, back to the line, as indicated. A circuit is also completed through the pilot-valve coil, the start and stop buttons, to the line. The pilot valve opens and the ignition system lights the pilot flame and it contacts the electrode. Then a circuit is completed from secondary S_1 through the flame, the flame electrode, resistor $\mathcal{R}_2$, cathode C_1 and anode A_1, back to S_1.

Grid G connects, through resistor $\mathcal{R}_3$, between the electrode and resistor $\mathcal{R}_2$, which puts a minus potential on this grid to block the circuit from cathode C to anode A. Condenser D is also charged and when the polarity of the transformer reverses, the condenser discharges through resistor $\mathcal{R}_2$ and maintains minus potential on grid G to block the circuit through $\mathcal{R}_4$ and S_2.

Absence of current through $\mathcal{R}_4$ removes minus potential from the grids of tube $\mathcal{T}_1$ and the relay coil is energized through it. A circuit for this coil is through secondary S_2, cathodes C_2, anodes A_2, secondary S_4 and the relay coil. Energizing this coil opens contacts $\mathcal{L}_1$ and $\mathcal{L}_3$ and closes contact $\mathcal{L}_2$. Opening contacts $\mathcal{L}_1$ and $\mathcal{L}_3$ opens the pilot-lamp and ignition-coil circuits, but the pilot valve is held open by a circuit through the pushbutton The pilot light going dark shows the operator that the pilot flame has been established and has contacted the electrode.

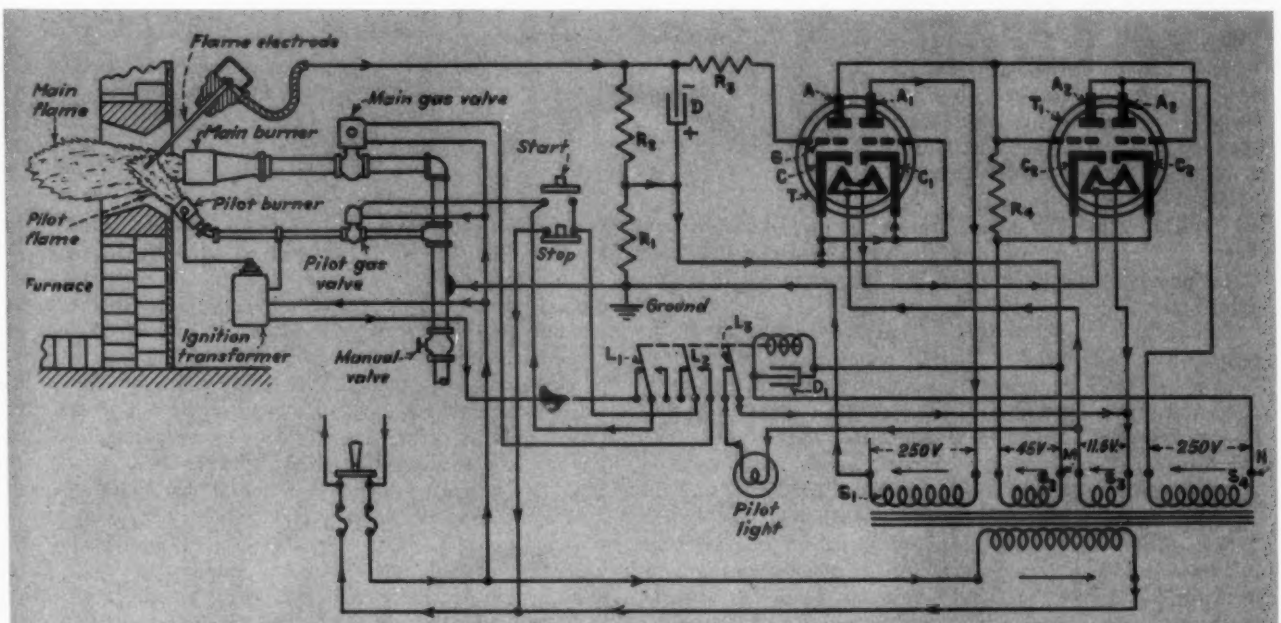
Closing contact $\mathcal{L}_2$ completes the main gas-valve coil circuit from the right-hand side of the line, through the main gas-valve coil, contact $\mathcal{L}_2$, the stop button, then to the left-hand side of the line. This valve opens and the operator holds the start button closed, releasing it when the main burner ignites. The main valve circuit remains closed through contact $\mathcal{L}_2$ and the stop button. As long as the flame contacts the electrode, the relay holds its contacts closed to the flame position.

Should the flame fail for any reason it will remove minus potential from grid G. This tube will again complete the circuit for secondary S_2 through resistor $\mathcal{R}_4$, to put minus potential on the grids of tube $\mathcal{T}_1$ and block the relay coil circuit. Its contacts then return to the start position and break the main gas-valve-coil circuit through contact $\mathcal{L}_2$, after which the valve closes. The system then remains in a safe no-flame position until the start button is pressed when the operations just described repeat.

During normal operation, pressing the stop button opens the main gas-valve coil and this valve closes. The operator holds the button open until he sees the pilot lamp light when he knows that the equipment has returned to safe no-flame position.

If the electrode were to bend down and touch the gas burner it would form a closed circuit to ground the same as when a flame exists. This danger is provided against because when the electrode grounds, condenser D discharges so rapidly that minus potential on grid G decreases to where its side of the tube conducts and makes tube $\mathcal{T}_1$ grids minus to block this tube. The tube then acts the same as when the flame extinguishes; the relay opens its contact to close the fuel valve and light the pilot light. This system is therefore protected against either breaking or short-circuiting of the electrode. If the electrode breaks and does not contact the flame, it creates no-flame conditions to close the main fuel valve automatically. Grounding the electrode also closes the fuel valve as previously explained.

Brown Instrument Co, Minneapolis-Honeywell Regulator Co, Bailey Meter Co, Ess Instrument Co, Wheelco Instruments Co, Combustion Control Corp and Stock Engineering Co, supplied information for this article.



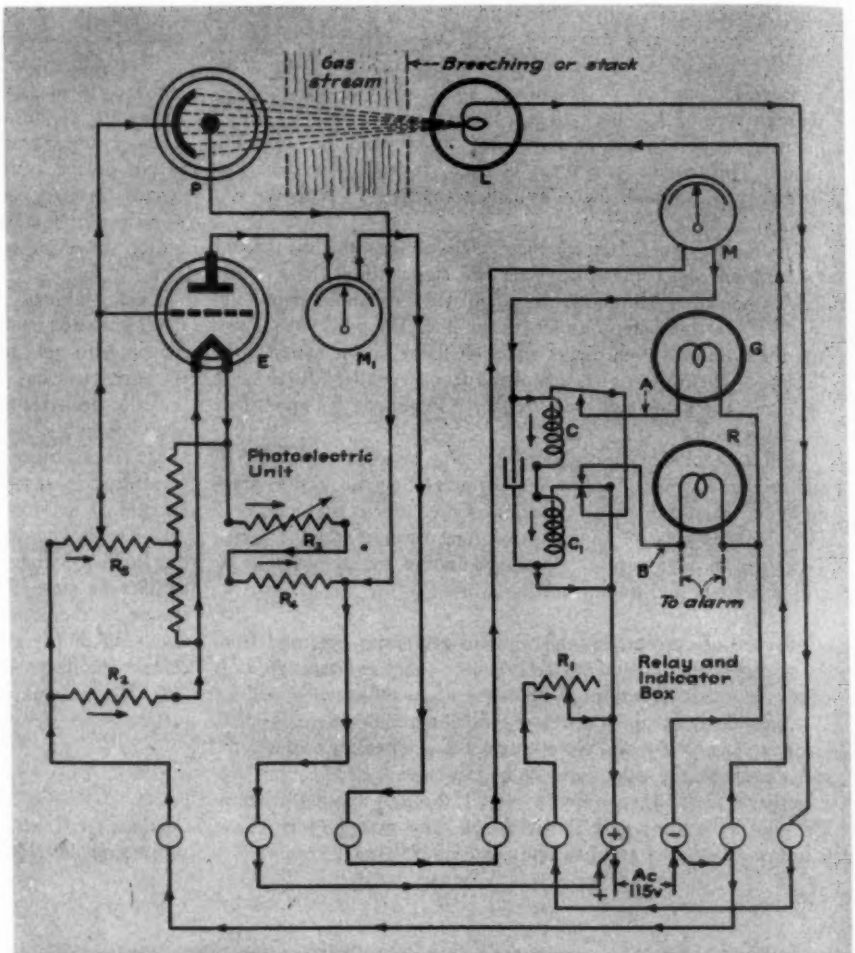
2 Flame-failure-protection system for gas-fired furnace includes a flame electrode, main solenoid-operated gas valve, solenoid-operated pilot valve and automatic ignition. Two twin-element grid-control high-vacuum electron tubes amplify impulses, providing sufficient power to actuate the working parts of the fuel and ignition system

SMOKE-DENSITY INDICATORS

SMOKE-DENSITY indicators and recorders were among the first applications of electron tubes to boiler operation. First developed as smoke detectors, these instruments now have a range and sensitivity that can read in the stack gases fine differences of haze that indicate small changes in combustion quality. Therefore, they are now more correctly called haze or combustion meters. They consist of three parts: (1) an indicator unit, with or without a recorder, placed conveniently for observation in the boiler room, (2) a light unit installed on the side of the stack or breeching in such a way that it directs a beam on (3) a photoelectric unit on the opposite side of the gas stream.

On the indicating unit a meter with a zero center scale reads zero when the haze density is correct for best combustion conditions. If the haze becomes too heavy the pointer reads to one side of zero, and to the other side if haze is too light. When haze density is not correct, two indicating lamps light—one when haze is too dense, the other when it is too light. Audible signals may also be operated when the density varies from that which indicates best combustion.

Fig. 1 shows the wiring diagram for one type of haze indicator that uses a photoelectric tube, $\mathcal{P}$, a three-element amplifying tube, $\mathcal{E}$, and a haze meter, $\mathcal{M}_1$, in the photoelectric unit. The indicator contains two relays, C and C_1, a haze meter, $\mathcal{M}$, and a red and a green light, $\mathcal{R}$ and $\mathcal{G}$. Power comes from a 115-v ac circuit, which we assume has the instantaneous polarity shown. Then, current flows from the — line through lamp $\mathcal{L}$ on the side of the breeching back through adjustable resistor $\mathcal{R}_1$ to the + line. Resistor $\mathcal{R}_1$ adjusts current through lamp $\mathcal{L}$ to give correct light density for the operating conditions. Lamp $\mathcal{L}$ through a lens throws a light beam across the gas stream on the photoelectric tube, $\mathcal{P}$.



1 A smoke indicator and recorder that uses a photoelectric tube for observing smoke color and a three-element amplifying tube to amplify photoelectric-tube current, which operates relays in the indicator circuit

Current also flows from the — line through resistance $\mathcal{R}_2$, cathode of tube $\mathcal{E}$, resistors $\mathcal{R}_3$ and $\mathcal{R}_4$ and to the + line. Adjustable resistor $\mathcal{R}_3$ provides a means of tuning tube $\mathcal{E}$ to the desired sensitivity. Photoelectric-tube circuit runs from — line through part of adjustable resistor $\mathcal{R}_5$, tube $\mathcal{P}$, to the + line. This circuit puts a minus potential on tube-$\mathcal{E}$ grid.

Tube-$\mathcal{E}$ grid potential depends on adjustment of $\mathcal{R}_5$ and the amount of light getting across the gas stream to photoelectric tube $\mathcal{P}$. When a dense smoke cuts off all light, tube $\mathcal{P}$ becomes inoperative and tube-$\mathcal{E}$ grid potential is maximum, causing minimum current to flow through $\mathcal{E}$. When gas is clear, as with too much excess air, maximum light reaches tube $\mathcal{P}$ and it conducts maximum current to put minimum minus potential on tube-$\mathcal{E}$ grid. As a result, this tube conducts maximum current.

Current also flows from tube-$\mathcal{E}$ cathode to its anode through meter $\mathcal{M}_1$, meter $\mathcal{M}$, relay coils C and C_1, to the + line. The equipment is usually so adjusted that with a haze density to give best combustion efficiency, current flow through tube $\mathcal{E}$ is just sufficient to hold pointers of meters $\mathcal{M}$ and $\mathcal{M}_1$ at midposition. This current is not sufficient to close relay C, but relay C_1 can hold its armature on its bottom contact. Under these conditions red- and green-lamp circuits are open through the relay contacts.

Assume that something happens to the fuel-air ratio in the furnace to increase stack-gas density, which reduces amount of light reaching photoelectric tube $\mathcal{P}$ and increases the minus potential on tube-$\mathcal{E}$ grid, as previously explained. This reduces current flow through tube $\mathcal{E}$, meters $\mathcal{M}$ and $\mathcal{M}_1$ and the relay coils to where relay C_1 releases its armature to close its top contact. A circuit for the red lamp is now completed from the — line through the red-lamp relay, C_1, top contact to the + line. The red lamp lights to call attention to the smoke conditions.

If gas density, due to too much excess air, decreases below a haze that indicates best combustion, more light reaches photoelectric tube $\mathcal{P}$ to decrease the minus potential on tube-$\mathcal{E}$ grid. Current flow then increases through meters $\mathcal{M}_1$ and $\mathcal{M}$ and relay coils to where relay C closes its contact. A circuit is now completed for the green lamp, $\mathcal{G}$, from — line, the lamp, contact of relay C, bottom contact of relay C_1, to the + line. Green

light indicates that stack gases are off color on the light side and the meters show the amount. If desired, a smoke-density recorder may be connected into the circuit at A and B.

Fig. 2 is a wiring diagram of a smoke-density indicator and recorder in which the relays, Fig. 1, are replaced by electron tubes. In this equipment the eye box contains a transformer, $\mathcal{T}$, a double-element rectifying tube, $\mathcal{E}$, a double-element amplifying tube, $\mathcal{E}_1$, and a photoelectric tube, $\mathcal{P}$. In the control panel there are two thyratron tubes, $\mathcal{E}_2$ and $\mathcal{E}_3$, a double-element rectifying tube, $\mathcal{E}_4$, two transformers, $\mathcal{T}_2$ and $\mathcal{T}_3$, and two signal lights, a red one, $\mathcal{R}$, and an amber one, $\mathcal{A}$.

Control of the equipment centers in two switches, one for the light source and one for the electric eye. Power for operation comes from a 115-v ac source. Assume both the light and the eye switches closed. To establish circuits in the eye box, assume line polarity opposite to that shown. Current then flows through resistor $\mathcal{R}_1$, light transformer $\mathcal{T}_1$ and back to – line. Secondary of transformer $\mathcal{T}_1$ supplies about 5 amp at 6-v to the lamp for the light beam across the gas stream to photoelectric tube $\mathcal{P}$. Resistor $\mathcal{R}_1$ provides for adjusting the light beam to suit the gas density where the equipment is installed.

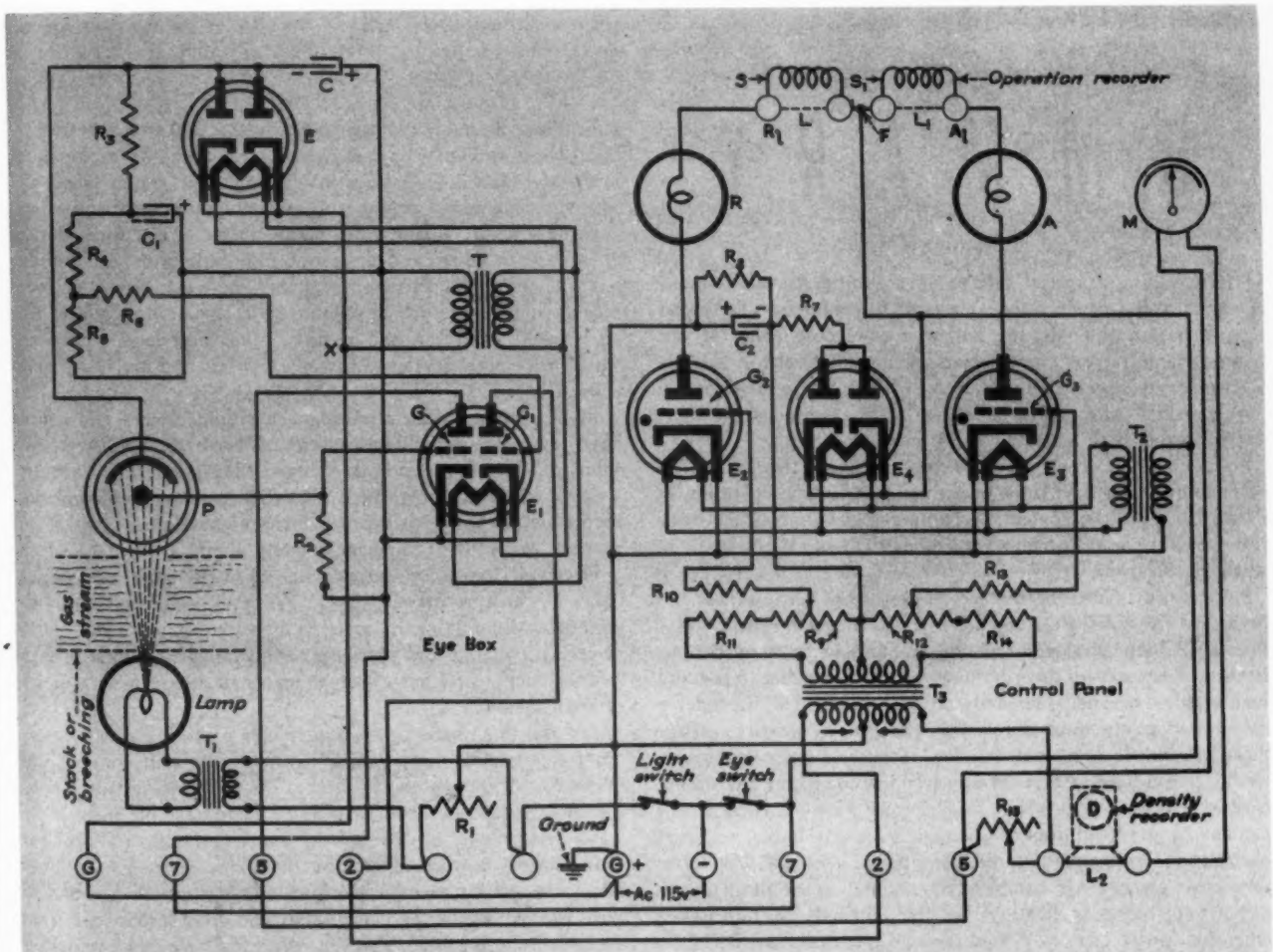
For the eye box, the circuits are from the + terminal through primary of transformer $\mathcal{T}$ back to the — terminal of the indicator panel. Secondary of transformer $\mathcal{T}$ connects to the cathode heaters of tubes $\mathcal{E}$ and $\mathcal{E}_1$, and heats them. From X a circuit continues through tube $\mathcal{E}$, tube $\mathcal{P}$, resistor $\mathcal{R}_2$, back to the line. Voltage drop across $\mathcal{R}_2$ puts minus potential on grid $\mathcal{G}$ of tube $\mathcal{E}$. From the anodes of tube $\mathcal{E}$ another circuit goes through resistors $\mathcal{R}_3$, $\mathcal{R}_4$ and $\mathcal{R}_5$, back to the line.

A tap taken from between resistors $\mathcal{R}_4$ and $\mathcal{R}_5$ through resistor $\mathcal{R}_6$ puts minus potential on grid $\mathcal{G}_1$ of tube $\mathcal{E}_1$. With normal conditions in the stack, potentials on grids $\mathcal{G}$ and $\mathcal{G}_1$ are equal. Tube $\mathcal{E}$ also charges condensers C and C_1 to the polarity shown.

Assume that polarity of the line reverses to that indicated. Current then flows through light transformer $\mathcal{T}_1$ and cathode-heating transformers $\mathcal{T}$ and $\mathcal{R}_1$, back to the line. With this line polarity, rectifying tube $\mathcal{E}$ becomes inactive because its anodes are now negative. However, condensers C and C_1 were charged on the previous half cycle. Condenser C discharges from its — side through tube $\mathcal{P}$, resistor $\mathcal{R}_2$, back to its + side to maintain grid $\mathcal{G}$ minus. Condenser C_1 discharges from its — side through resistors $\mathcal{R}_4$ and $\mathcal{R}_5$, back to its + side to maintain — potential on grid $\mathcal{G}_1$ of tube $\mathcal{E}_1$.

For the polarity shown on the indicator panel, one circuit is from the — terminal through the primary of transformer $\mathcal{T}_2$ and back to the + line. Secondary of this transformer heats cathodes of tubes $\mathcal{E}_2$, $\mathcal{E}_3$ and $\mathcal{E}_4$. A circuit is also from the — line through tube $\mathcal{E}_4$ resistors, $\mathcal{R}_7$ and $\mathcal{R}_8$, to the + line.

Voltage drop across resistor $\mathcal{R}_7$ puts minus potential on grid $\mathcal{G}_2$ of tube $\mathcal{E}_2$, through part of resistor $\mathcal{R}_9$ and resistor $\mathcal{R}_{10}$ and also through the left-hand half of $\mathcal{T}_3$ transformer secondary, resistors $\mathcal{R}_{11}$ and $\mathcal{R}_{10}$. A minus potential is applied in a similar manner to tube $\mathcal{E}_4$, but through resistors $\mathcal{R}_{12}$ and $\mathcal{R}_{13}$, also through the right-hand half of $\mathcal{T}_3$ transformer secondary and re-



2 In this smoke-density indicator, the eye box contains a photoelectric tube, a double-element rectifying tube and amplifying tube that controls the firing of two thyratrons in the indicator circuits on the control panel

sistor R_{14}. Tubes E_2 and E_3 are inactive during this half of the cycle because their anodes are given — polarity through lamps R and A. For the same reason, tube E_4 is inactive during the next half of the cycle, but condenser C_2 was charged on the half cycle just considered and it discharges from its — side through resistor R_8 and keeps minus polarity on tubes E_2 and E_3 grids, through the circuits previously described.

Primary of control transformer T_3 for tubes E_2 and E_3 is energized through tube E_1. These circuits are from — line to terminals 7, the right-hand cathode and anode of tube E_1, the left-hand terminal of transformer T_3 to its middle tap, to + line. The other circuit is to the left-hand cathode and anode of tube E_1, part of resistors R_{15} and meter M to the right-hand half of transformer T_3 primary to its middle tap and the + line.

Indicating-meter M connects across resistor R_{15} and, with normal gas conditions in the stack, its pointer takes a vertical position, as shown. Current flow in the two halves of transformer T_3 is in opposite direction and when these currents are equal, as with normal gas conditions, they neutralize each other so that they do not produce a flux to energize the secondary winding. Under these conditions, tube E_4 impresses a — potential on the grids of tubes E_2 and E_3 of a value that just prevents them firing.

Assume that the stack gases darken, then less light will reach photoelectric tube P and less current will pass through resistor R_2, causing a reduction in — potential on grid G. This lets more current flow to the left-hand anode than to the right-hand one, which in turn permits more current to flow in the right-hand side of transformer T_3 primary than in its left-hand side. As a result, a voltage is induced in the secondary of this transformer that makes the grid of tube E_2 less minus and that of tube E_4 more minus, and tube E_2 fires to light red lamp R.

When terminal G becomes minus, the red-lamp circuit is from the — line through tube E_2, lamp R and, if a recorder is not used, from terminal R_1 to F and back to the + line. More current also flows through indicator M to deflect its needle to the left of midposition and show amount stack gases have darkened.

If the stack gases become more clear than normal, showing the presence of too much excess air, then current flow through photoelectric tube increases. This increases the potential on grid G and reduces current flow through the right-hand part of transformer T_3 primary. This permits left-hand end of the primary to establish the secondary potential which is opposite to that for gas more dense than normal. Now the grid of tube E_4 is made less minus and it fires to light amber lamp, A. A circuit for this lamp is from terminal G, through tube E_3, and lamp A to terminals A_1 and F, back to the + line. Less current also flows through meter M and its pointer swings proportionally to the right to show the amount the stack gas is under color.

Either one of two recorders may be used. When an operation recorder is used, links L and L_1 are removed, and then the lamp circuits are through the recorder's coils, S and S_1. When the red lamp lights, coil S is energized. Lighting the amber lamp makes coil S_1 active. This recorder shows only that the stack gas is off color and for how long it is off color, but does not record the density of the gas. To use a density recorder, D, remove link L_2 to put D and M in series. D records the amount the stack gas is off color and in what direction, that is, it records the amount needle of meter M is deflected, and the direction of its movement.

The Ess Instrument Co, Brooke Engineering Co, Bailey Meter Co, Leeds & Northrup Co and Preferred Utilities Co assisted in the preparation of this article.

SUMMARY

WHEN writing a special section on a subject having as many ramifications as electronics, even when confined to the power and industrial fields, the author must choose either of two courses. He may treat a few subjects comprehensively, or attempt to cover many superficially. Here the former has been done because detailed information on a few applications has far more practical value than a smattering on many.

An attempt has been made to lay a foundation of practical fundamentals first, and show how they apply in the operation of several classes of equipment. Accordingly, the first article deals with the electron, an incomprehensible particle of electricity about which the electronic art is built.

Electron tubes have been treated extensively because they are the means by which electrons are released and controlled. These tubes have been developed and are available in so many designs that it is necessary to describe only the more common types and their simplest circuits. The chart on pages 70 and 71 includes a wide variety of these tubes and gives their characteristics and applications, but the list is not complete because of space limitations.

All electron tubes can be used as rectifiers to change alternating to direct current. They range in size from a simple two-element vacuum or gas-filled tube, no larger than a thimble, to great mercury-arc designs that handle thousands of kilowatts. The latter have been given fairly complete treatment because of their importance for power applications. In 1943, about 10% of all power generated in this country passed through electronic rectifiers.

In the treatment of rectifiers, automatic voltage regulators, motor control, flame safeguards and smoke-density indicators and recorders, emphasis has been placed on how they operate. Electronic-equipment circuits have too often been treated as a mystery, something not readily comprehended by practical electrical workers and power and industrial engineers. However, the explanations in the preceding articles show that these circuits are as simple and as easily understood as those of conventional control equipment.

Because of space limitations many classes of electronic devices of interest to power and industrial engineers have been omitted, but will be covered in future articles. These equipments include: turbidity indicators, which operate on a similar principle to that of a smoke indicator and recorder; flow and level controllers, which have been developed in several forms and are being given wide attention.

In the field of electric welding, electronic devices and control have revolutionized old processes and made possible new ones. Industrial electronic control, a broad classification, includes resistance welding, timing, speed regulation, power-factor regulation, regulation of power to heating furnaces and other applications that are part of the equipment in many plants.

Electronic frequency converters come in two classes of applications: (1) as a tie between 25- and 60-cycle systems and (2) for converting from 25 or 60 cycles to high frequency, in the heating of metals, plastics and plywoods. Even though the first is in its infancy, the second has grown to man's stature in a wide variety of applications.

Air cleaning, building-heating-system control, electric-elevator control, metering, temperature measurements and control, automatic synchronizing of ac generators, lighting-system control, locating of flaws in metal parts and relaying are but a few of the ways electronic devices are solving power and industrial problems.

In closing, a word of caution should be given. Electronics is not a cure-all for every power and industrial problem. These devices can improve many old methods and do new jobs that cannot be done by any other means, but they, like any other equipment, have their limits. Therefore, when applying them make sure they are going into a proper place where they will improve a product, lower cost of production, increase output or produce economic, safety or other benefits.

Safe Speeds for Cast-Iron Flywheels

The 'mile-a-minute' rule of thumb for safe rim speed of cast-iron flywheels is too cautious for some designs and not safe enough for others. Chart of safe speed explained by T C Rathbone, Fidelity and Casualty Co of New York*

▸A "MILE-A-MINUTE," or perhaps 100 ft per sec, is the familiar expression for limiting safe rim speed of cast-iron flywheels having solid rims, with percentage reductions based on "joint efficiencies" for the built-up type. It is usually assumed that this simple rule includes a factor of safety sufficient to warrant no further concern.

Analysis indicates that this rule is unnecessarily stringent for solid wheels having relatively thick and heavy rims, while providing a much scantier margin of safety than is generally expected as the rim becomes proportionately thinner, as with pulley-type wheels. This situation results from over generalizing to obtain a rule of thumb in the interest of simplicity.

Under emergency conditions, old machinery is being pressed into fullest use. The question of maximum allowable speed often arises, making desirable a more detailed analysis of centrifugal stresses for particular cases. The more accurately and completely various wheel stresses can be calculated, the less allowance need be made for residual unknown and extraneous stresses.

Spokes Affect Stress

Nearly all handbook information and present methods used by insurance companies are based on either simple hoop-tension calculations or a series of model experiments carried out by Professor Benjamin at the turn of the century. Also, the "efficiencies" of the various rim joints as found by these experiments are based on the theoretical capacity of the solid rim in simple hoop tension. This is obviously improper as the solid rim with integral spokes may itself develop only a fraction of the speed capacity of a rim unconstrained by spokes.

Although it has been recognized that complex bending stresses are set up in the rim because of the spoke constraints, little attempt has been made to evaluate these stresses for general practical application. Instead, a safety factor designed to include such stresses is applied to the simple hoop-tension formula:

$$S = \frac{12w}{g} V^2$$

where

w is weight per cu in.
g is gravity, 32.2 ft per sec per sec
V is rim velocity in ft per sec
S is stress in psi.

For cast iron at 0.26 lb per cu in., this reduces almost exactly to the familiar expression:

$$S = \frac{v^2}{10}$$

The *bursting* velocity is:

$$V = \sqrt{10 \times \text{tensile strength}}$$

which, for cast iron at 19,000 psi, would be 436 ft per sec.

Safe rim velocity is usually expressed:

$$V = \sqrt{\frac{10 \times \text{tensile strength}}{\text{factor of safety}} \times \text{joint eff}}$$

The factor of safety appears in this formula under the radical; that is, a factor of safety of *nine* on stress amounts to a factor of safety of only *three* on speed. The commonly used limit of 100 ft per sec for solid rims results from a safety factor of *ten* based on 10,000 psi as the tensile value of cast iron, as proposed by W H Boehm** around 1902.

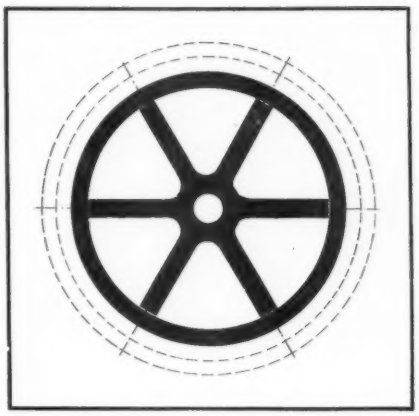


Fig. 1—If the rim and spokes were not rigidly connected, the rim radius would increase three times as much as the spokes would stretch for any speed

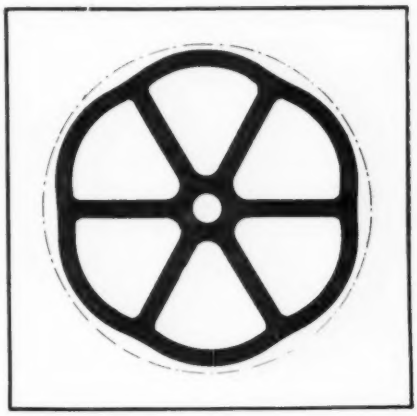


Fig. 2—Spokes of actual flywheel constrain the rim, causing it to warp out of round. This distortion creates bending stress on inside of rim next to spoke

In reality, this factor of safety is nearer 19 to 20 on stress considering hoop tension alone, but this is materially reduced for thin-rim construction with large bending moments.

When a flanged joint is added to the thin-rim construction, the situation becomes worse. Boehm wrote, "As a matter of fact, few wheels have a margin of safety of 73% on speed. The Amoskeag wheel burst on a 20% increase in speed and many wheels today run on a narrower margin than this."

Professor Benjamin's experiments, as described in *Transactions of ASME for* 1898 *and* 1902, were made on cast-iron models of existing flywheels, 15 and 24 in. diameter. In all, 33 such wheels were driven to bursting speed. Of these, twelve were the solid type, two had rims in halves with shrink links, and eight were the bolted-flange type. The remainder were of special constructions, some not in general use. Modern, accurate speed indicators were evidently not available and variations of 2 to 5% are probably to be expected. However, these experiments seem to be the only actual bursting tests described in the

* Republication rights reserved.

** Formerly vice-president and chief engineer, Fidelity and Casualty Co of New York, retired, who initiated flywheel insurance. See *Engineering News*, Oct 1, 1903, and *American Machinist*, Nov. 17, 1904.

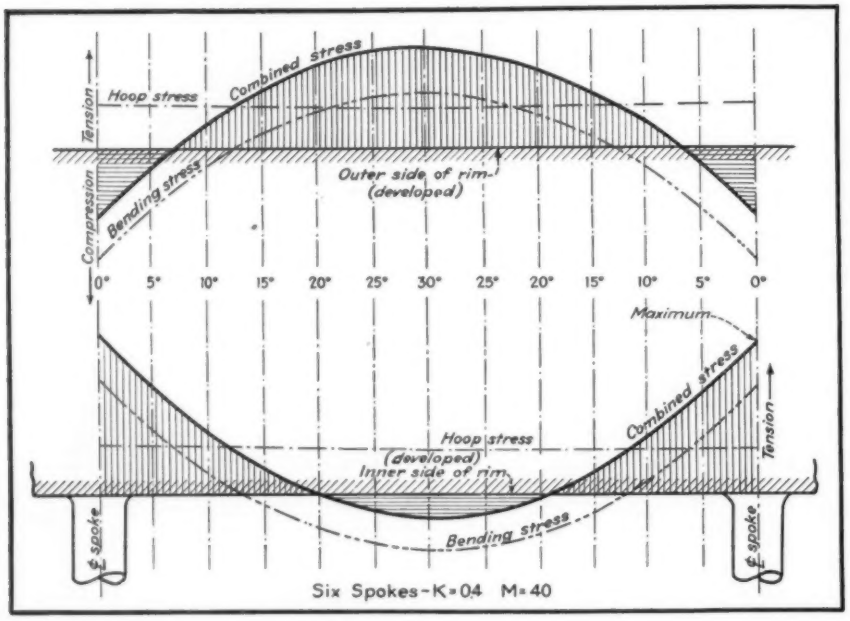


Fig. 3—Length of vertical lines indicates magnitude of combined stress in rim between spokes. Note that maximum tension occurs where spokes meet inside of rim

literature. There have been many flywheel explosions but accurate speed data and other information are generally missing.

In technical reports describing the tests, the apparent stress at failure is calculated from the simple hoop-tension formula ignoring the bending effect. However, when the burst-test data is analyzed on the basis of combined bending and hoop stress, it becomes apparent that bending plays a very large part in the failure, particularly for thin rims. The modulus of rupture in bending must be considered as well as simple tensile strength. Thus, the relative thickness of the rim to the diameter and spoke section becomes important.

Built-up Rims

It also becomes apparent that the failure of built-up rims with various joints is probably more influenced by the relative rim proportions than by the nature of the fastening itself. The shrink-link joint is commonly assigned a considerably higher efficiency than the bolted-flange type, but rims using shrink links must necessarily be heavy to accommodate them. Bolted flanges, on the other hand, are usually associated with thin-rim pulley-type wheels. The lug on the flange joint adds greatly, of course, to the bending moment. Incidentally, most of the model failures occurred in the rim at the junction with the spokes where the bending stress is greatest, and in most cases the joints merely opened by stretching the bolts.

The fact that existing criteria have proved fairly satisfactory, particularly for heavy construction, is accounted for by the large factor of safety on hoop stress, plus empirical reductions for joints based on the Benjamin tests. As stated before, this results in a large margin for heavy solid-rimmed wheels, which, however, decreases rapidly as the rim becomes thinner.

To understand the rim stresses, assume that the flywheel of Fig. 1 is so constructed that the spokes are not rigidly connected to the rim but can slide in radial guides. Upon rotation, centrifugal hoop stress in the unconstrained rim causes it to stretch to a greater diameter while the spokes also lengthen somewhat because of centrifugal force acting on their own mass. An analysis shows, however, that the rim radius increases three times as much as the spokes stretch. These relative distortions are shown to an exaggerated scale by the dotted lines.

Rim stress, for this condition, is simple hoop tension. For cast iron, the value can be computed approximately by taking one tenth of the square of the rim velocity. With this arrangement (with wire spokes, for example) the maximum rim strength can be utilized. For very thin rims, the average stress can be taken as the actual stress, but for thicker rims this is not true as stress at the inner side of the rim is appreciably greater than on the periphery. This complication can be readily avoided, however, by basing all calculations of rim stress on the *outside* diameter rather than the *mean* diameter. It can be shown that the resulting value will always be slightly greater than the maximum stress at the inside.

In practice, the spoke is either cast with the rim or otherwise rigidly attached. Spokes constrain the rim from expanding in a true circle so that it bends outward between spokes. This superimposes a bending stress on the hoop-tension stress, which materially increases the total stress on the inside of the rim near each spoke.

The rim, in trying to distort to its natural diameter under centrifugal force, exerts a pull on the spoke which must be added to centrifugal stress in the spoke itself. The spoke is further elongated by the rim pull, relieving part of the rim bending. A balance is reached when the resistance of the spoke to further stretching matches the resistance of the rim to further bending. Computation of resulting stresses requires the use of calculus.

The amount of superimposed bending stress depends greatly on relative proportions of rim and spokes. Light spokes, such as those in a bicycle wheel, exert little restraint on the rim, which forces the spokes to stretch all the way out to a new diameter. In this extreme case, it might seem that stress in the spokes would become a limiting condition but it can be shown that total stress in the spokes (with no hub) do not exceed nominal hoop-tension stress in the rim by more than 16%. Since spoke stress for all usual wheels is much less than this extreme value, it can safely be assumed that spoke stress due to centrifugal force does not exceed the nominal hoop tension.

Rim Distortion

As the spokes become heavier and the rim section lighter, the rim is compelled to bend more and more inward to the relatively unyielding spokes. This results in the kind of distortion pictured to an exaggerated scale in Fig. 2. The relative intensities of hoop tension and bending stresses (for an assumed case) have been plotted in Fig. 3, representing the developed rim between two spokes. Combined tensile stress is greatest next to the spoke and on the inside of the rim, while the outside of the rim over the spoke is actually in compression because of the preponderant bending moment. Bending stresses in the rim become surprisingly great for extreme proportions. Increasing the number of spokes decreases the span of bending and hence the stress.

It is evident that all solid wheels cannot properly be grouped as a single class for assigning safe speeds. Design

proportions and number of spokes must be taken into account.

Exact calculation of combined hoop and bending stress is quite complicated and tedious. Analyses of the stress in solid wheels have been published*** including rather involved formulas for spoke tension, hoop tension and bending moment, but these are much too cumbersome for practical and ready use.

However, these formulas can be greatly simplified by introducing certain assumptions and ratios defining the wheel characteristics. Assuming that the rim is rectangular, and solving for the maximum stress at the underside of the rim at the spokes, the equations reduce to:

$$\text{Maximum combined stress} = S_b + S_t$$

$$S_b = \frac{V^2}{10} \times \frac{2MK}{QK + 2\pi}\left(Q - \pi Cot\frac{\pi}{Q}\right)$$

$$S_t = \frac{V^2}{10}\left(1 - \frac{2.0944K \times Cot\frac{\pi}{Q}}{QK + 2\pi}\right)$$

where

K is the ratio: $\dfrac{\text{mean spoke-section area}}{\text{rim-section area}}$

M is the ratio: $\dfrac{\text{rim diameter}}{\text{rim thickness}}$

Q is the number of spokes

S_b is bending stress

S_t is hoop stress

These expressions still look formidable to the practical engineer in the field, but they can be still further simplified by specifying the number of spokes:

$$\text{Stress}_6 = \frac{V^2}{10}\left(1 + \frac{(0.56M - 1.81)K}{3K + 3.14}\right)$$

$$\text{Stress}_8 \text{ ‖ } \frac{V^2}{10}\left(1 + \frac{(0.42M - 2.53)K}{4K + 3.14}\right)$$

$$\text{Stress}_{10} = \frac{V^2}{10}\left(1 + \frac{(0.33M - 3.22)K}{5K + 3.14}\right)$$

where subscripts denote number of spokes.

These formulas readily lend themselves to presentation in graph form, Fig. 4, where solid lines represent values for wheels with six spokes, and broken lines, eight spokes. For convenience, the chart is plotted in terms of *bursting speeds* using 38,000 psi as

(*Continued on page* 146)

*** *Strength of Materials* Part II, 1930, Timoshenko and *Elements of Machine Design* Part II, 1920, Unwin and Mellanby.

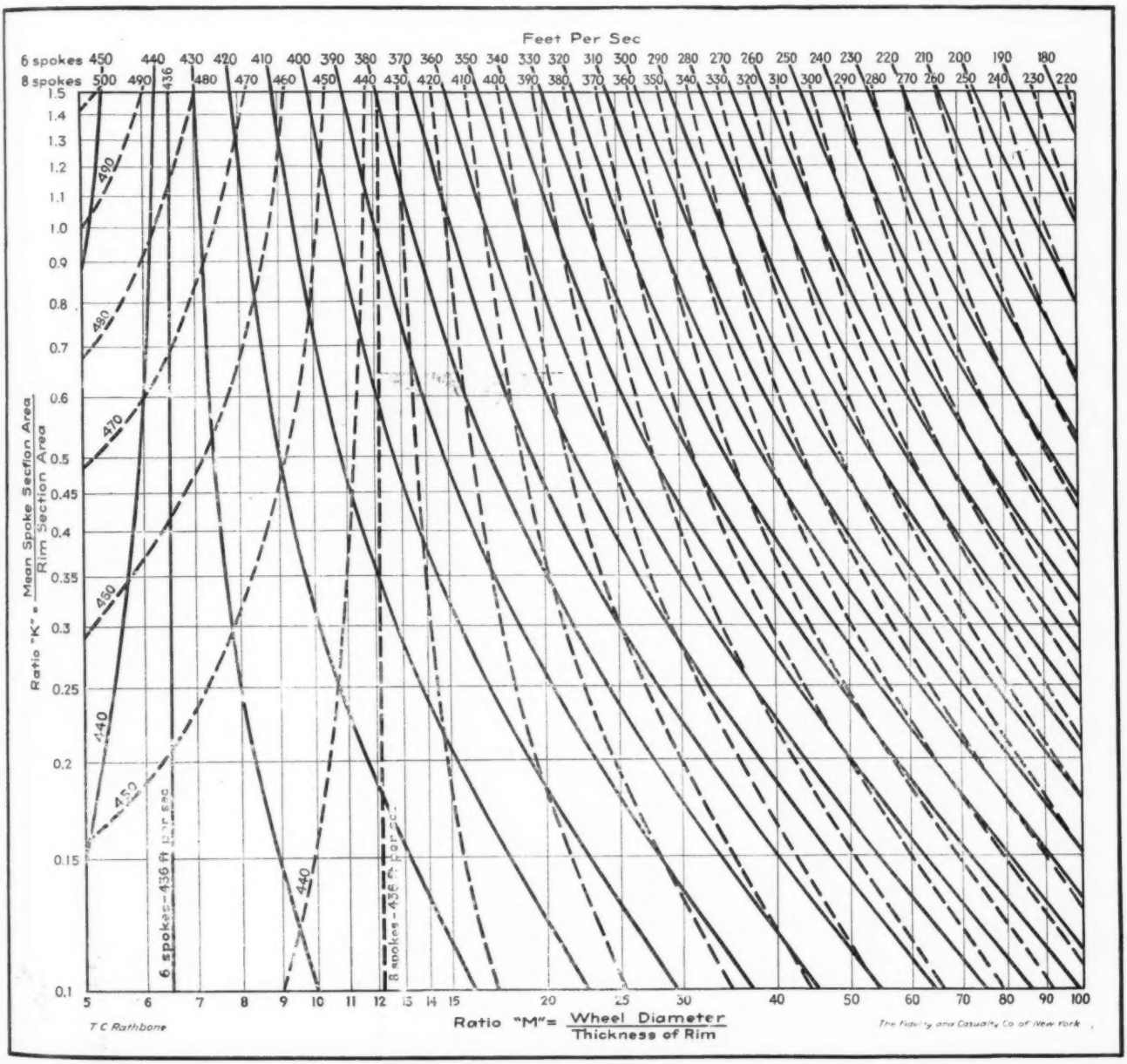


Fig. 4—Calculated bursting speeds of solid cast-iron flywheels, balance wheels and pulleys, based on maximum combined hoop and bending stresses with material assumed to have tensile strength 19,000 psi and modulus of rupture in bending 38,000 psi

HOMEMADE ACCESSORIES Step Up Boiler Performance

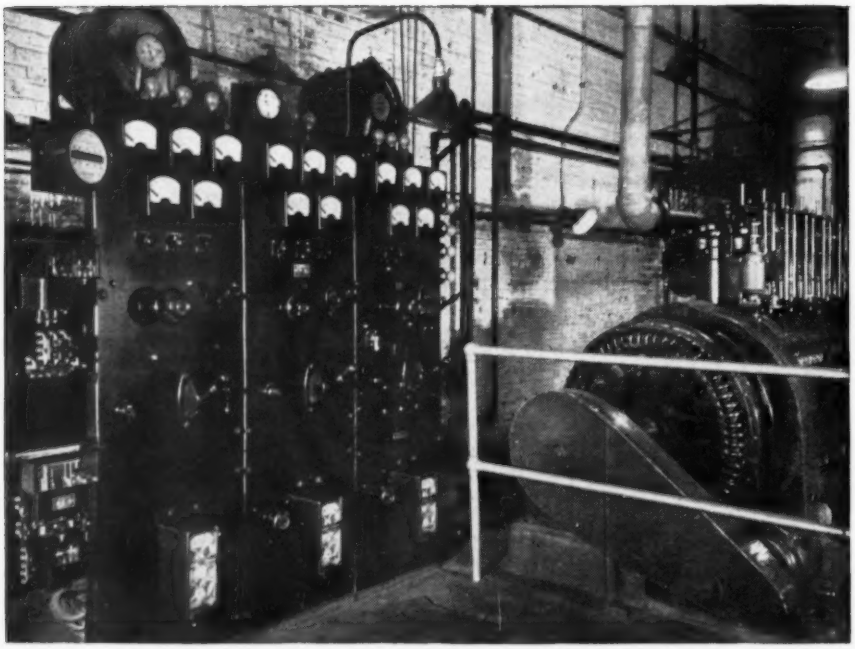


Fig. 1—Purchased power feeds through a safety switch directly to main bus in rear of station switchboard. Wood dummy fuses prevent tying the systems together

▶ ALTHOUGH S H Becker's real responsibility, as chief engineer of the Youngs Rubber Corp, is supervision of power production and distribution, he finds time for constant improvement of the many complicated process machines. The power plant alone has chalked up to his ingenuity a heat exchanger, made from a 50-gal metal drum by removing one head; a boiler-compound pot that is an inverted-bucket trap body; and a stack temperature indicator from a discarded pH meter.

Plant Setup

Before describing these homemade inventions in detail, this in brief is the setup of his plant. Steam for process and space heating comes from either of two boilers, one 175 and the other 200 hp, at 80 psi. Sterilizers, water cleaners, curing ovens and several space heaters utilize steam at boiler pressure, while air-conditioning units for drying and curing, water-filled testing tanks, latex drum-cleaning tanks and remaining space heaters use steam at 15 and 25 psi.

Automatic controls employing both heating and refrigerating units maintain year-round temperature of 80 F in the latex-mixing and test-machine rooms and 74 F in the packing room and office. Air conditioner for latex-mixing room recirculates 85% of the air.

Condensate from drum-cleaning tanks, water-filled testing tanks and boiler-feed pumps goes to waste. Remaining condensate returns by gravity to a float-controlled receiver in the boiler room. Float movement has direct control of boiler-feed pump and does a good job of regulating the boiler-water level. Makeup, comes from a softening unit that furnishes water for factory process. Then the makeup goes through the air-compressor cooling system, and acts as condensing medium in a still furnishing distilled water for process requirements. Overflow from the still goes into a heat exchanger fed by exhaust steam from boiler-feed pumps.

This heat exchanger is the one that Engineer Becker made from a 50-gal metal drum: Removing one head from the drum provided an open vessel into which a suitable pipe coil could be in-

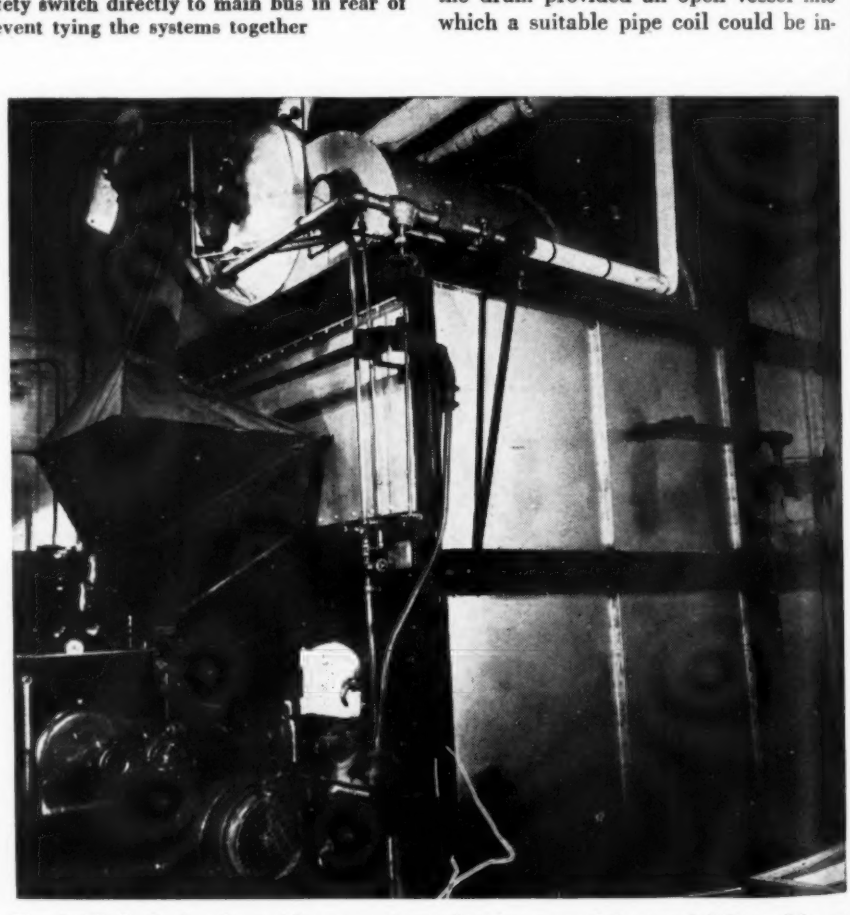


Fig. 3—Underfeed stoker with automatic combustion control fires coal delivered by an overhead conveyor. Ashes are removed by hand and wheeled outside the plant

You can often convert odd parts that have outlived their original purpose into workable devices that take on new and useful duties. Here's how one power engineer did just that to the tune of better plant operation

serted and piped to feedwater-pump exhaust. Makeup water circulates around the steam coil.

After picking up heat units from these sources, makeup water enters the receiver through a hand-regulated valve. Excess water passes to waste from the heat-exchanger overflow, deficiencies being made up by a separate float-controlled makeup line entering this unit.

With a few exceptions, where traps lift the condensate approximately five feet to return lines, remaining condensate drains directly to the lines by gravity. All traps for the same pressure have their connecting unions placed on the same centers to permit quick and easy interchange. Weekly checks with a stethescope held against the trap case tell whether it is leaking or failing to operate. No attempt is made to repair leaky trap valves; they are replaced by new ones.

At one time serious corrosion appeared in several unit-heater radiators,

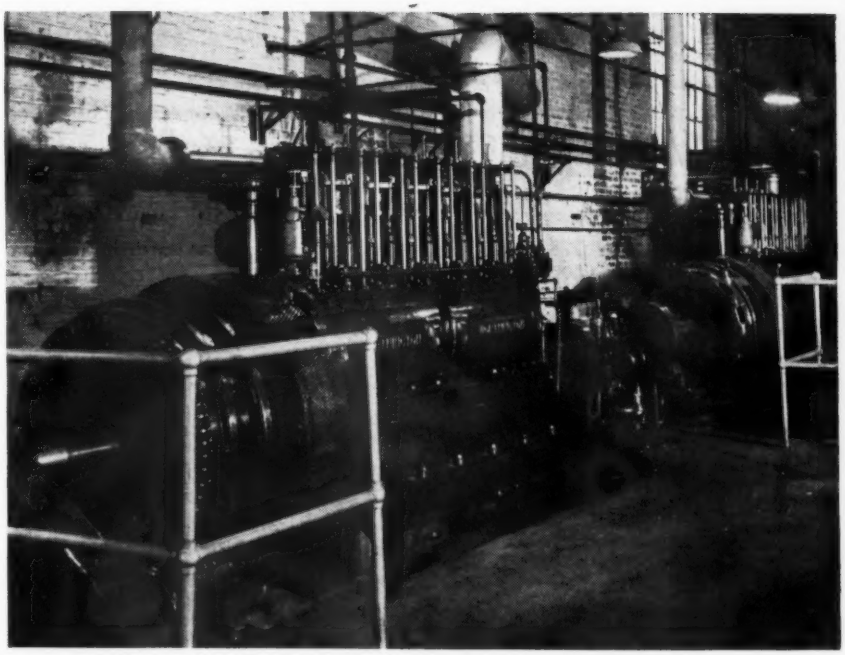


Fig. 2—Two of the diesel-engine-driven generators that furnished plant power previous to oil rationing. Periodic operation without load keeps the windings dry

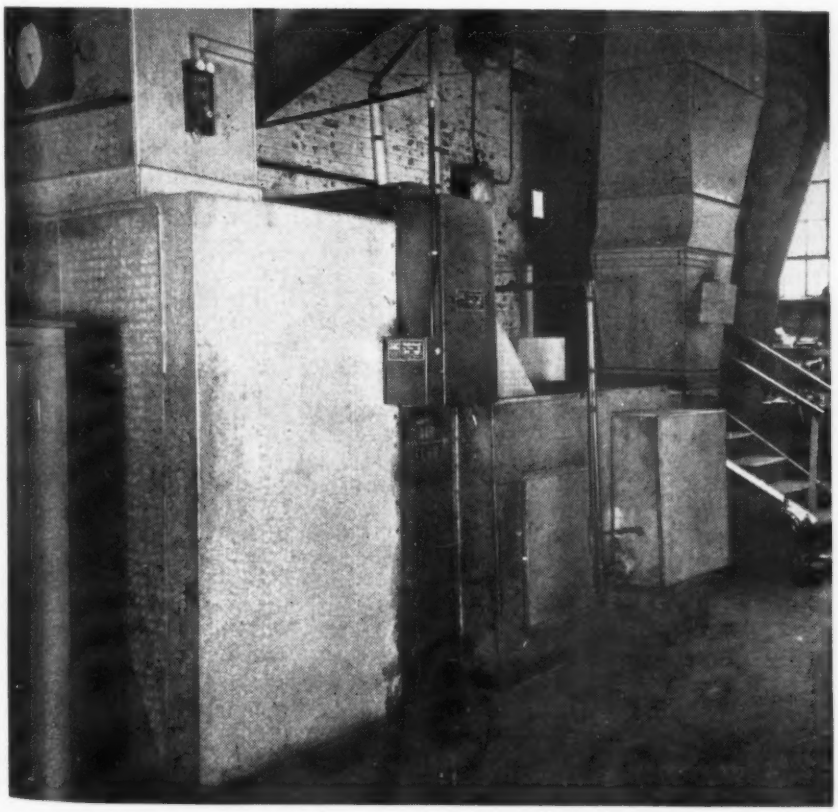


Fig. 4—Air conditioner contains heating and refrigerating units which maintain 80 F in the latex-mixing room. Steam supply and condensing unit located in rear

necessitating their replacement. The cause was traced to the boiler compound pot attached to feedwater line. When adding compound, operators had been in the habit of closing the pot without filling it completely with water. Air pocketed in this space found its way into the boiler and then into the distribution system. An appreciable amount of air entered the system, as compound was added every eight hours. Now, after it is added, the pot is completely filled with water, which has eliminated further corrosion. The pot, by the way, is the one made from an inverted-bucket trap body.

Boiler tests made by recognized methods showed an evaporation rate of eight pounds of steam per pound of coal. Performance is continually checked by a counter mounted on the reciprocating boiler-feed pump.

A mixture of 2-in. nut and slack coal, dumped from railroad cars into bins beneath the track is hauled in wheelbarrows to a conveyor that carries it to underfeed-stoker hoppers on each boiler. Knowing the average weight of a wheelbarrow load and keeping a record of the number dumped gives the total weight of coal fired. A complete combustion-

(*Continued on page* 170)

How to Hookup Diesel Indicators

More about methods of keeping your diesels on their toes—practical pointers on laying out, building and using indicator reducing motions

► THE KEY TO TOPNOTCH diesel operation lies in knowing what's going on inside the cylinders, and the best way of finding out is regular use of an indicator. Last month's article outlined indicator principles, described types commonly used and pointed out the reasons for the various kinds of cards that are made. This article tells how to hookup an indicator, either for the simple *draw* card or the regular *pressure-volume* diagram.

Draw, or *pressure-time*, cards require only a connection between engine cylinder and indicator cylinder. Most engine cylinder heads or walls carry plugged tapped holes or threaded plug cocks for connecting an indicator. Indicator manufacturers offer plug valves of special design, which fit into the tapped holes and on which the indicator itself mounts. In general, such a valve should present as short and straight a gas passage as possible; a long and tortuous passage may mean errors from pressure drop in the valve and inertia of the gas.

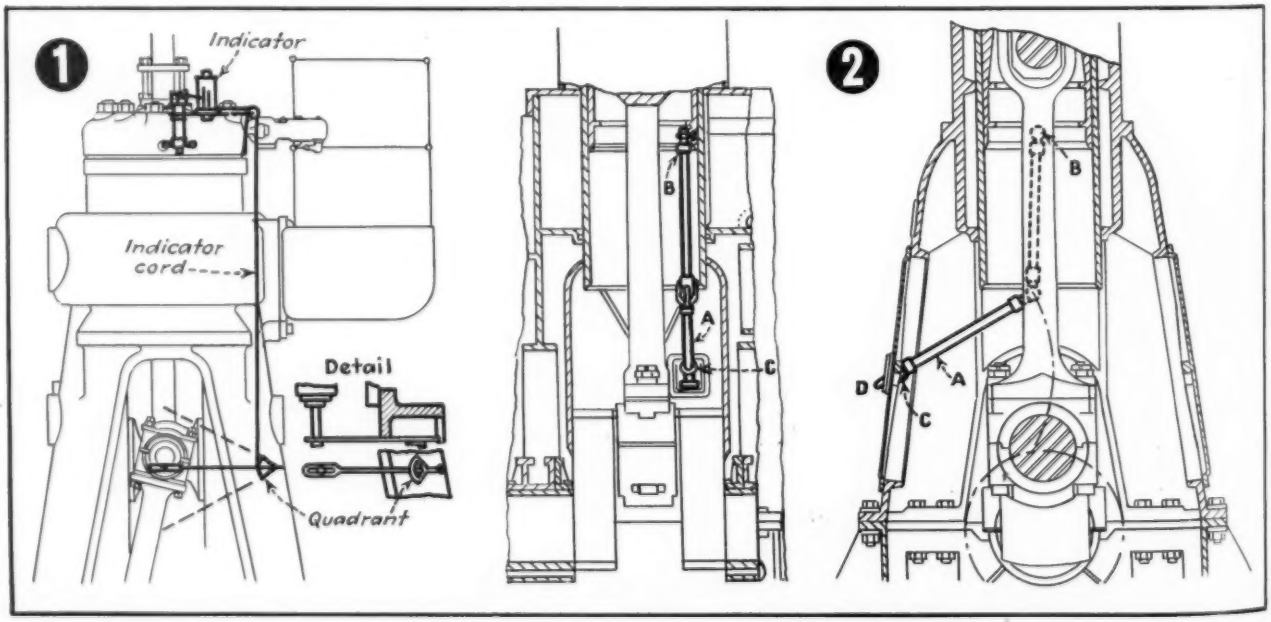
In addition to the gas connection just discussed, an indicator to be used for making pressure-volume diagrams requires a reducing motion of some kind to transmit the piston movement to the indicator drum. Few engines come from the factory equipped with such devices, but homemade riggings prove entirely satisfactory if properly designed and maintained in good condition. The first requirement sounds simple but many riggings fail to meet it: the point to which the indicator cord connects must move in a constant relationship to the piston movement. In addition, rigging design should eliminate backlash as far as possible and minimize the effect of cord stretch. Keeping cord length to a minimum avoids adding excessively to the drum mass, which might introduce inertia errors.

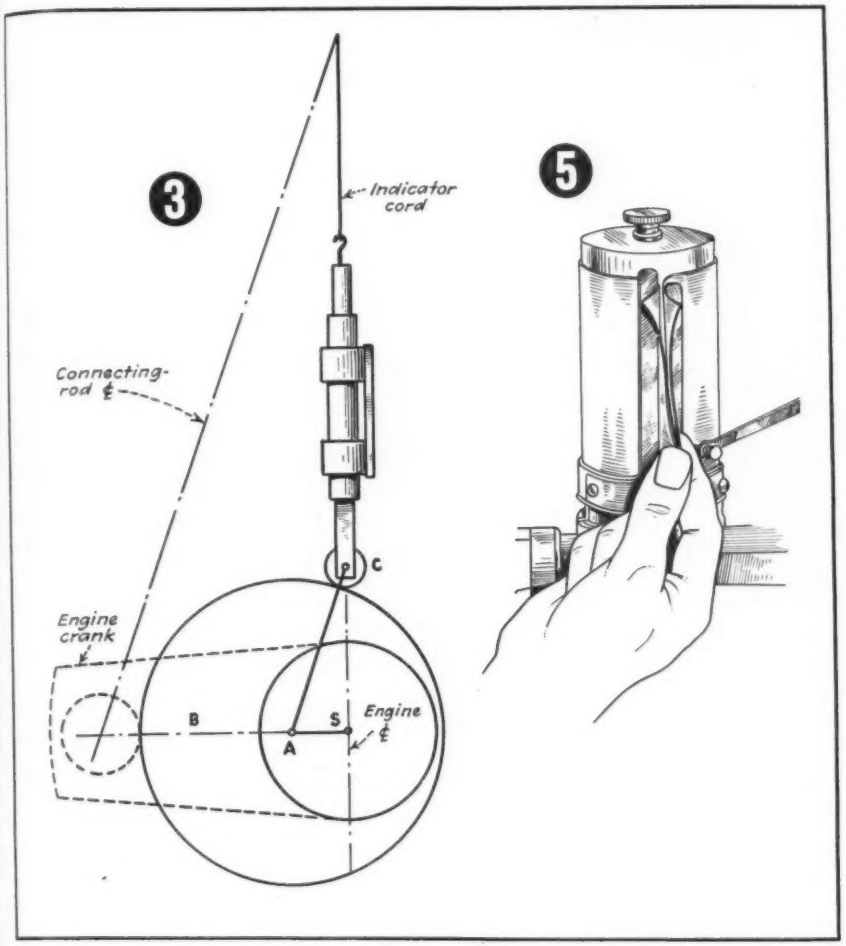
The diesel indicator diagram is narrow and variations in it that spell trouble are usually small. This means that a fairly high order of accuracy is required and thus the methods of rigging indicators on steam engines usually prove unsatisfactory, even on crosshead diesels. On trunk-piston engines an entirely different arrangement is called for, of course.

A simple reducing motion for a crosshead diesel is shown in (1). A lever, pivoted at one end on the engine frame, connects to a stud extending from the crosshead. The stud projects far enough for the lever to clear any obstructions and slides in the slotted end of the lever. The cord connects to a quadrant fastened to the lever at a point near the pivot; diagrams will be accurate if the quadrant is properly made. With this connection, the cord draws out against spring tension as the piston moves downward. If the cord stretches, the diagram distorts at the end of the expansion stroke, which is not so serious as an equal stretch at the other end of the diagram.

For trunk-piston engines, some engineers use hookup (2). Lever *B* fastens to the piston inner wall by a screwed pin; rocker *A* fulcrums on a pin *C* at the side of the crankcase door and fastens to lever *B* by a ball-and-knuckle joint. Indicator cord loops over hooked end *D* of rocker *A*. If lever *A* is made of such a length that the knuckle joining *A* to *B* moves equal distances on the two sides of the cylinder center line, the diagram proves essentially accurate; otherwise, an error is involved. When the piston moves upward, indicator-spring tension increases. If the cord stretches, distortion occurs at the end of the compression stroke and during the combustion period, just where accuracy is most important.

On trunk-piston engines, it often proves simpler to drive the indicator





from the crankshaft than from the piston. One method is shown at (3), consisting of an eccentric, *B*, clamped to the engine shaft with its throw, *A*, in line with the engine crank. The radius of the eccentric, *B*, plus the radius of roller, *C* (distance *AC*), must be in the same proportion to connecting-rod length as the eccentric throw is to the crank throw:

$$\frac{AC}{\text{connecting-rod length}} = \frac{AS}{\text{crank throw}}$$

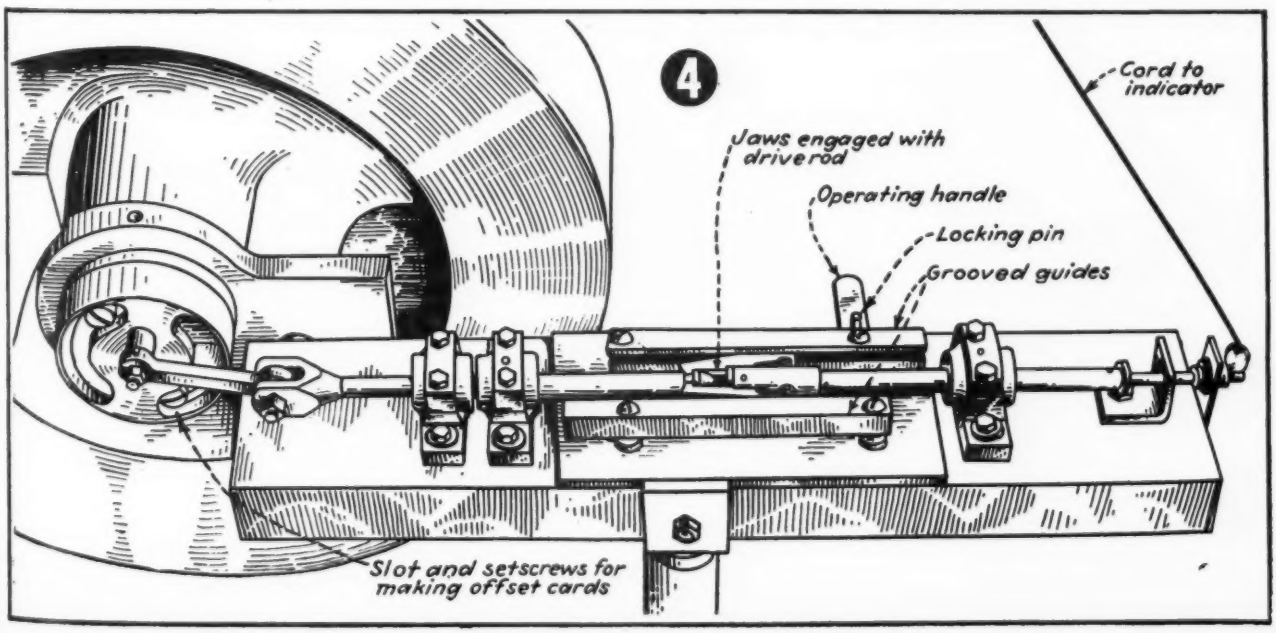
As this motion is usually built, a piece of steel rod forms the slide and a length of pipe lined with babbitt serves as a guide, fastened to some convenient part of the engine frame. The eccentric can be made of cast iron or steel, split and drilled for clamp bolts; in an emergency hardwood with brass edging will serve.

Instead of the eccentric, some engineers drill the end of the engine shaft for a small cap screw or pin. A small connecting rod runs from the pin to the sliding member. If the rod length bears the same relation to the engine rod length as the distance from shaft center to pin bears to the crank throw, this device will reproduce on a miniature scale the action of engine crank and rod.

This general idea finds use in a more elaborate reducing motion developed at Pratt Institute (4). Slotted holes in the engine-shaft connection permit changing the phase of the indicator relative to the piston, enabling offset cards to be taken. Designed for engine speeds in excess of 1000 rpm, this motion embodies careful design to eliminate play and backlash, and a special detent motion for conveniently engaging and disengaging the indicator while the engine is running. A full description of this motion, and a working drawing, appeared in POWER, Feb. 1941, pg 84.

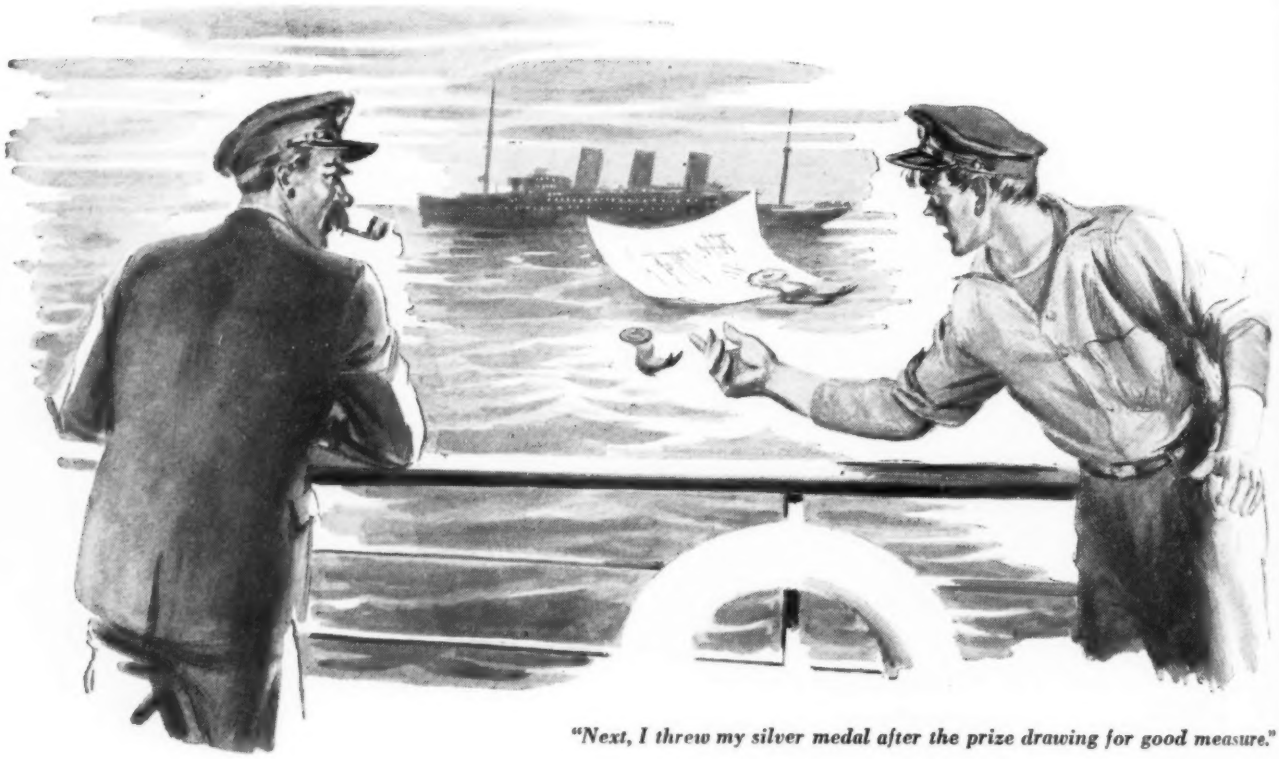
These motions, and others devised by ingenious engineers, do a good job if properly maintained and used. Check equipment for backlash and play each time it is used. Look to the cord as well; it should resist stretching without being stiff. Having selected a flexible woven-wire or high-grade linen line, the next step is to make a separate cord for each cylinder and mark them for future use.

(*Continued on page* 168)



THE OLD CHIEF

'SCOTS WHA SAIL'



"Next, I threw my silver medal after the prize drawing for good measure."

On his first seagoing trip, a cocky young engineer learns that Scotsmen who wear 'deepsea bonnets' accord recognition to all comers in proportion to reliability, capability and experience. Another story by William Doran, chief engineer, Essex Co Sanatorium, Ont.

I ALWAYS ASSOCIATE stocktaking time at the old plant with late hours, restaurant snacks, dust, grease and headaches. No matter how soon we started the job, we always had to work our heads off to complete it before December deadline.

I recall one of those occasions when the Old Chief, the head stockman and I left the plant in the small hours of the morning. We were tired, but happy in the thought that our inventory was completed for another year. We dropped into a restaurant on the way home—in preference to waking up our folks. The stockman was named Ian (pronounced Een) McIvor. He was a thickset Scotsman with a broad, rasping Scotch accent and a good sense of humor. He had at one time been a ship's purser. Our conversation turned to the large numbers of Scotsmen who follow the sea in general and marine engineering in particular, and I was privileged to hear from the Old Chief the story of his first seagoing trip as an engineer.

"There was a time," said the Old Chief, "when I would willingly have shot every Scotsman who wore a 'deepsea' bonnet, and that happened when I signed up as a junior engineer. I had not long completed my apprenticeship and I was just as cocky and opinionated a young punk as ever walked across the fiddlings of a ship's engine room. Some of my overconfidence may have been due to the fact that I had finished with top marks in mechanical drawing in the little night school of my home town; packed away in my suitcase, I had a drawing of the control mechanism of a gantry crane which had won for me the silver medal award for the best drawing of the year. I was not at that time very serious about following marine engineering. My particular ambition was to become a top-ranking office drawing man, or perhaps a great naval architect.

"My only desire in going to sea was to secure the necessary experience to enable me to write for a marine engineers' board-of-trade certificate.

"There are four things that I will always associate with that first trip of mine—seasickness, the smell of fresh paint, the smell of hot oil and, most of all, Scotsmen. The first three I believe are part of the job, but the latter were surely placed there by providence for the purpose of debunking brash know-it-all junior engineers. There were three McLean's on board, but no relation to each other. The Chief hailed from Argyleshire, the 'Third' was of the Perthshire branch of the clan, and the old oiler told me in confidence that he came from the highland or whiskey-supping branch of the family.

"I had never met men who were so uninterested in what I considered my bright and breezy conversation. I found them very hard to talk to. They were

(*Continued on page* 136)

Southern California Replaces Lend-Lease Turbines

Completed in six months, a new 84,600-kw turbine in the Long Beach station replaces the capacity of two older machines, which the Government's wartime order removed for emergency shipment outside the country

By W. L. CHADWICK, *Chief Civil Engineer*
Southern California Edison Co, Ltd

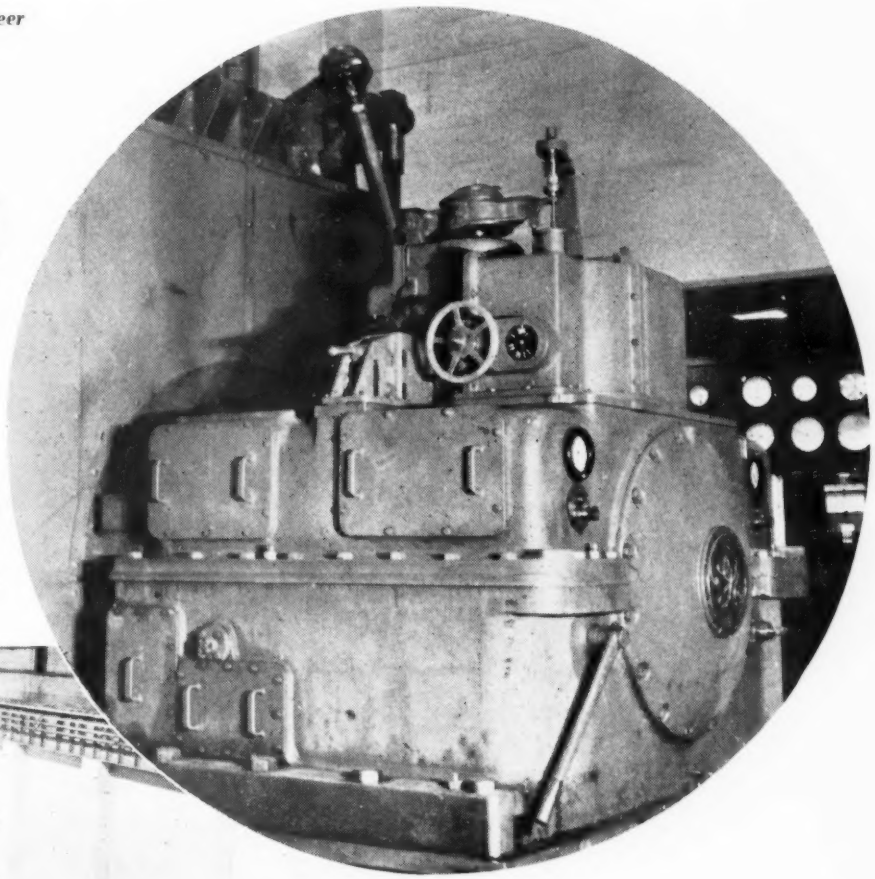
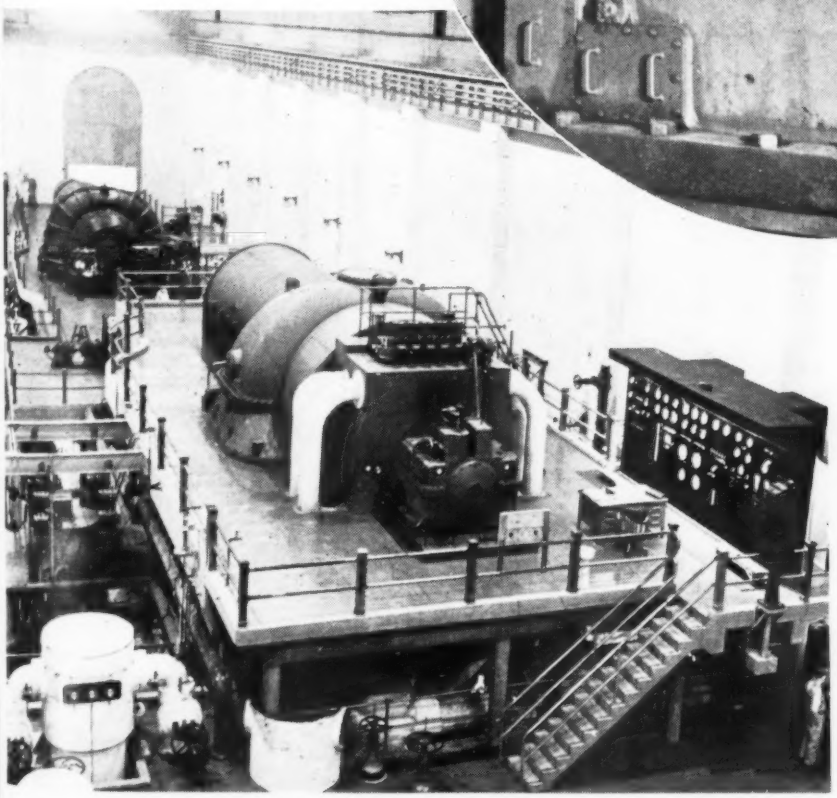


Fig. 1—Two separate governors provide for normal operation at either 50 or 60 cycles, as required by Pacific Southwest Power Interchange Committee

Fig. 2—Intended for installation in the midwest to operate at 850-psi 900-F steam conditions, this turbine was redesigned during early stages of manufacture to utilize 375-psi 700-F steam from existing boilers. The 60,000-kw machine in background dates back to 1926

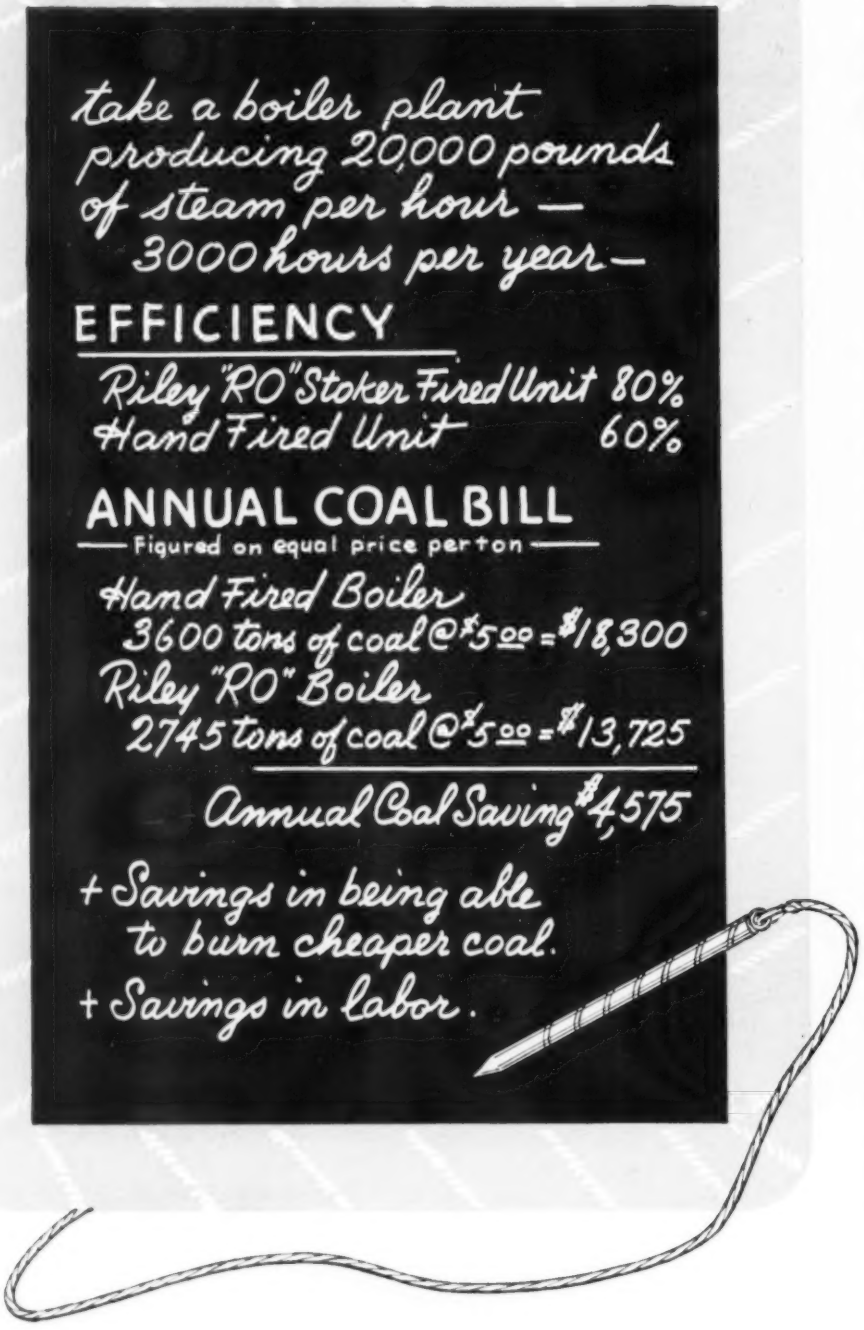


► FINDING FREQUENCY, condition and size of two 42,500-kw 50-cycle turbines adapted to its purpose, the procurement division of the United States Treasury Department, late in 1942, requisitioned these units for lend-lease shipment to one of the United Nations. This nation had suffered so heavily in production capacity as a result of the loss of a large power development that relief was considered necessary in less time than would be required for the manufacture of new machines.

The work of removing two units and replacing them required a total of approximately ten months from the time

(*Continued on page* 98)

Lets see what savings can be made


take a boiler plant
producing 20,000 pounds
of steam per hour —
3000 hours per year —
EFFICIENCY
Riley "RO" Stoker Fired Unit 80%
Hand Fired Unit 60%
ANNUAL COAL BILL
Figured on equal price per ton
Hand Fired Boiler
3600 tons of coal @ $5.00 = $18,300
Riley "RO" Boiler
2745 tons of coal @ $5.00 = $13,725
Annual Coal Saving $4,575
+ Savings in being able
to burn cheaper coal.
+ Savings in labor.

Actual results in the field prove that stoker, pulverized coal or oil fired Riley "RO" Boiler Units generally operate at efficiencies above 80%. It is also generally agreed that to obtain an efficiency of 60% with hand fired boilers is doing just about as good as possible.

★

This difference in efficiency represents a saving of 25% in fuel costs alone without taking into consideration additional savings resulting from being able to burn a considerably cheaper grade of coal or savings in labor.

★

The large savings resulting from the installation of modern efficient Riley "RO" Boilers invariably pay for the investment within a few years. The apparent necessity for maximum post war economies in production costs warrants careful investigation of this excellent opportunity for reducing costs.

★

When considering new boiler equipment, it is well to remember that Riley "RO" Boilers in general operate at considerably higher efficiency than standard brick set boilers. Some of the reasons why are given on the following page.

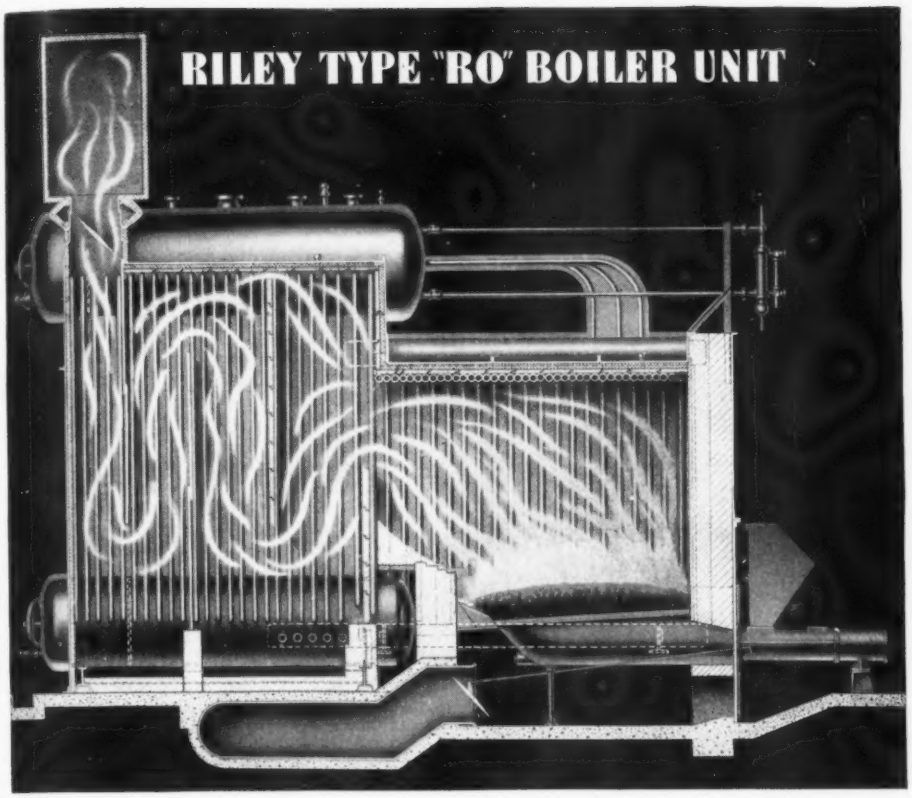
RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Baltimore Buffalo Cleveland Detroit Chicago St. Louis Cincinnati
St. Paul Kansas City Denver Seattle Portland Los Angeles Houston New Orleans Atlanta Memphis

It will pay you to visit modern Riley Installations

by installing Riley "RO" Boiler Units



For Capacities between 7500 and 100,000 lbs. per hour
THE RILEY TYPE "RO" STEAM GENERATING UNIT

Advantages of Riley "RO" Boilers

RAPID POSITIVE CIRCULATION—Due to the large hydrostatic head, resulting from large distance between upper and lower drums, rapid positive circulation and consequently high heat transfer efficiency is obtained.

ECONOMIZER SECTION—An economizer section built integral with the boiler assures low flue gas temperatures and a minimum loss of heat up the stack.

WATER COOLED FURNACE AND ROOF—Side walls and roof are water cooled, affording a large percentage of radiant heating surface. Fuel burning equipment can operate at maximum efficiency as clinker difficulties are eliminated.

AIR TIGHT INSULATED SETTING—Since the casing is air tight, losses due to infiltration of cold air into the boiler is prevented. Ample insulation used in the setting reduces radiation losses to a minimum.

MINIMUM OF MAINTENANCE—With rapid positive circulation heat is quickly carried away from the tube surface by the boiler water, preventing tube failures due to overheating. As side wall refractories are protected by the water walls, refractory maintenance is very low.

These well-known companies have found it profitable to install Riley "RO" Boilers

American Steel & Wire Co.
Goodyear Tire & Rubber Co.
General Electric Co.
Scovill Mfg. Co.
Revere Copper & Brass Co.
Curtiss-Wright Corp.
American Brass Co.
Packard Motor Car Co.
Nicholson File Co.
The Bullard Company
Eagle Picher Lead Co.
Pepsi-Cola Co.
Monsanto Chemical Co.
Reilly Tar & Chemical Co.
Mead Corporation
Wickwire Spencer Steel Co.
Publicker Comm. Alcohol Co.
U.S. Gypsum Co.
Pet Milk Co.
Armour & Co.
Nunn Bush Shoe Co.
Hercules Powder Co.
G. G. Conn Co.
Isaacson Iron Works
Int. Minerals & Chem. Corp.
Behr Manning Co.
Modine Mfg. Co.
Republic Creosoting Co.
A. O. Smith Co.
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A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • FLUE GAS SCRUBBERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • AIR HEATERS

before purchasing Boiler or Fuel Burning Equipment

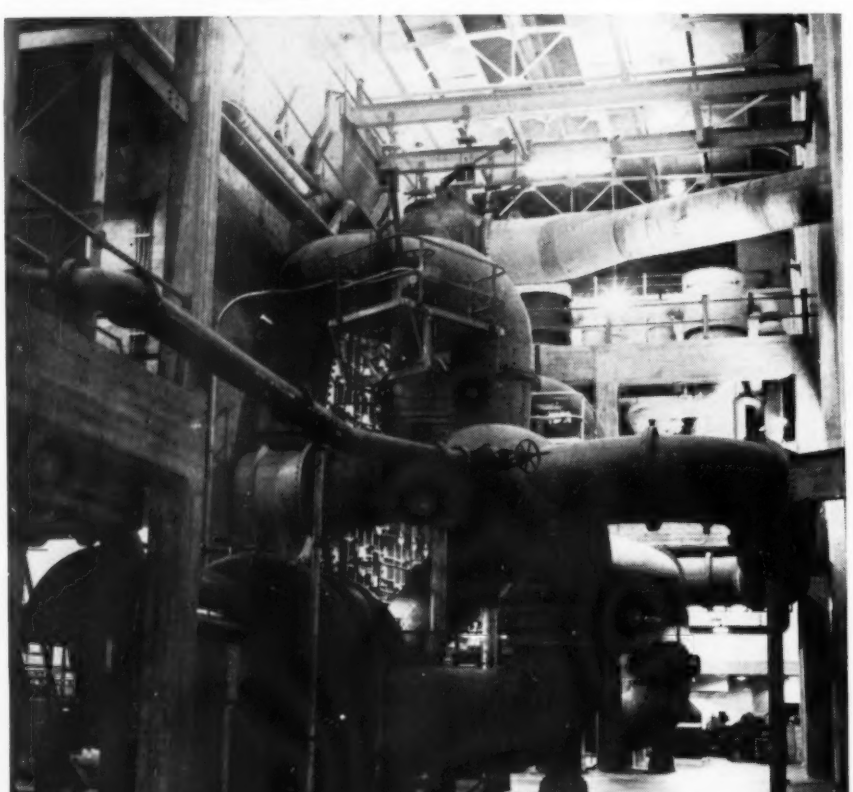


Fig. 3—Critical situation prevailing in early 1943 on new large pumps was successfully met by switching two circulators from the older 60,000-kw unit and, for replacement, adapting leftover pumps from one of the lend-lease machines

the first turbine was posted by the government representatives to the time of admitting first steam to the new machine. At the time that the Lend-Lease Administration, through the War Production Board, suggested that the two machines be removed for its purpose, the utilities in the Pacific Southwest were forming what has since become the Pacific Southwest Power Interchange Committee. Its purpose was to integrate utility systems of that area, toward the end of requiring use of least practicable amount of critical materials and equipment for new generating resources. This integration had become particularly necessary not only because of the heavy war demand from existing manufacturing plants, but also because of extremely heavy demands on the same area for aluminum and magnesium reduction.

Record Time

Under these conditions, earliest possible replacement of the requisitioned generators was highly important, from the standpoint of the Southern California Edison Co. as well as the Pacific Southwest area. With the excellent cooperation of all interested parties, including WPB, replacement has been effected in record time.

Southern California Edison operates a combination hydro and steam system which, in years of normal precipitation, derives most of its generation from hydro plants in the Sierra Nevada mountains and from a portion of the Boulder power plant of the Department of the Interior. Under heavier loadings and in years of less than normal precipitation, however, hydro generation unable to supply system load, is supported by Long Beach steam station.

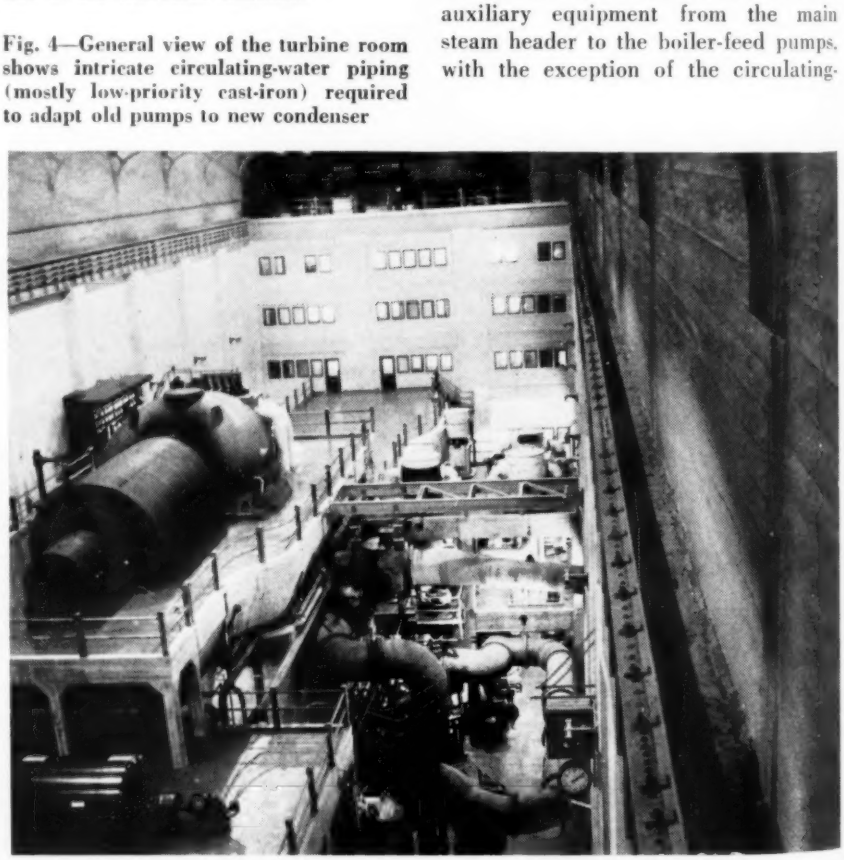
Three Plants

Prior to the recent changes, this station, comprising three separate plants, contained the following turbine-generator units (POWER, January 28, 1928): Two 100,000-kw 450-psi 750-F units installed in Plant No. 3 in 1928 and 1930; one 60,000-kw unit installed in Plant No. 2 in 1926; two 42,500-kw 375-psi 700-F units installed in Plant No. 2 in 1924 and 1925; three low-pressure units, aggregating 22,500 kw, installed in Plant No. 1 in 1924; and three vertical units, aggregating 47,500 kw, installed in Plant No. 1 between 1911 and 1913.

The 60,000-kw unit is currently leased to the City of Los Angeles, but the remainder of the station serves the Edison system as emergency and dry-year standby, as annual peak-load support, and as spinning reserve—all as required.

The requisitioned equipment, and hence the equipment that it was necessary to replace, comprised the turbine and generator, condenser, and all other auxiliary equipment from the main steam header to the boiler-feed pumps, with the exception of the circulating-

Fig. 4—General view of the turbine room shows intricate circulating-water piping (mostly low-priority cast-iron) required to adapt old pumps to new condenser



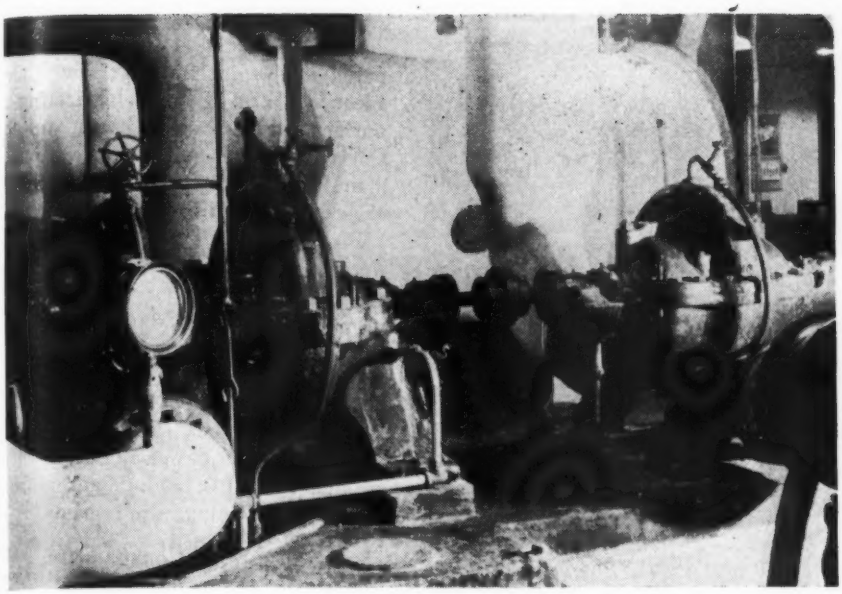


Fig. 5—In anticipation of possible future conversion of auxiliaries to 60 cycles, two condensate-booster pumps in series are now driven by a single motor at 50 cycles

water pumps and piping. The latter pumps were not taken with the units, because their head characteristics did not conform to the requirements of the foreign station site.

At first, the suggestion for removal of the two units was accompanied by a proposal that the Southwest power area be furnished equivalent capacity in an additional steam unit placed on another Southern California system. Further consideration, however, showed the desirability of replacing the lost capacity on the same system from which it was removed.

Representatives of the Office of War Utilities, WPB, offered lists of available equipment. Included was information that manufacture of an 80,000-kw 100,000-kva machine had been undertaken for a Midwest utility as part of an expansion program that had recently been canceled. Investigation developed that, although this machine had been designed for 850 psi, 900 F, manufacture had only been started, and the machine could still be adapted to Long Beach steam conditions. Also, for the same Midwest utility, a 75,000-sq-ft surface condenser had been put under contract.

Adapted Equipment

A new contract provided for completing this turbine-generator, and for building the condenser to the design originally prepared for the Midwest utility, but for manufacture by Allis-Chalmers. With WPB's assistance, a search was made of the entire country for available equipment. With the exception of pumps, a few valves and some piping, the required heaters and auxiliary equipment were obtained either from canceled installation excess stock or from resulting canceled equipment orders. A very considerable amount of adapting was obviously necessary.

To adapt the original design to 375-psi 700-F steam conditions obtaining at Long Beach, the manufacturer increased turbine steam-admission areas and provided two steam supply lines. To fit dual frequency conditions obtaining on the interconnected Southern California systems, the turbine was equipped with two separate governors, one for 50-cycle and one for 60-cycle operation. The unit had an original nameplate capacity of 80,000 kw, and 100,000 kva; after modification, it had a guaranteed gross output capacity of 84,605 kw at 50 cycles and 85,295 kw at 60 cycles. At 50 cycles and 1500 rpm, the generator voltage will be 11,500; at 60 cycles and 1800 rpm, the voltage can be controlled between 12,000 and 13,800. This feature will permit delivery of energy either to the Edison 50-cycle system or, by isolating a transmission tie, to the Los Angeles area at 60 cycles.

Each of the two generator windings is connected to a separate 39,000-kva transformer bank remaining from the original installation. The generator is totally inclosed and equipped with self-contained heat exchangers, permitting the use of hydrogen as a cooling medium and condensate as a coolant. The direct-connected exciter is air cooled.

Because of the short time, Allis Chalmers built the condenser to C H Wheeler Co design, originally prepared for the unit when on order for the Midwest location, the latter company cooperating under the emergency conditions by releasing its drawings. The condensate pumps and air-removal equipment are Allis-Chalmers' design. The critical situation regarding pumps, particularly large units, was successfully met by switching two circulating-water pumps from the station's 60,000-kw unit to serve the new machine, and installing two of the pumps that formerly served the requisitioned units to supply the condenser of the 60,000-kw unit. The adapted circulators supply the new condenser with 85,000 gpm of Pacific Ocean water taken from adjacent Long Beach Harbor.

The condenser design calls for 75,000 sq ft of cooling surface. No. 18 BWG aluminum brass condenser tubes were obtained by an agreement to omit, for the duration, 10% of the number required for full design surface. Because of the critical situation affecting copper at the time, it became necessary to use steel condenser tube sheets instead of Muntz metal. This substitution was, however, made with considerable misgivings, because the circulating water, like that for the rest of the station, is received from the Pacific Ocean, and no information was available from any source on the life of steel tube sheets under such conditions.

Coated Tube Sheets

The manufacturer conducted accelerated tests to determine what protective coatings could be applied to the tube sheets. On the basis of the test results and other information, a carefully applied coating of zinc was sprayed on the completed condenser tube sheets, followed by impregnation with special varnish.

This protective coating lasted only eight days on the tube sheets, although it is apparently satisfactory in the condenser water boxes. Pending the results of additional experimental work, the manufacturer protected the tube sheet with four applications of Debecote, and with the same material coated the inside of each tube a distance of eight inches at each end.

The 17-stage turbine was originally designed by General Electric for steam extraction at four points. As rearranged, extraction is made from the eighth, tenth and thirteenth stages. The calculated maximum throttle steam flow, at 375 psi, 700 F, is 904,000 lb per hr. With a condenser pressure of 1.5 in. Hg and full extraction for feedwater heating, the expected gross generator outputs will be 84,650 kw at 50 cycles, and 86,312 kw at 60 cycles. Corresponding guaranteed heat rates are 11,440 and 11,220 Btu per

net kwhr for operation at 50 and 60 cycles, respectively.

Power for auxiliaries is taken through a transformer bank from the 50-cycle-system transmission bus. To anticipate the possibility of future conversion of the system to 60 cycles, new pumps and motors were, where possible, designed for initial operation at 50 cycles and future conversion to 60-cycle operation.

Tandem Pumps

Condensate booster pumps between the deaerating heater and the boiler-feed pumps consist of units of two pumps in series, driven by one motor. Both pumps are required to develop full discharge head at 50 cycles, and only one pump will be required with the motor operating at 60-cycle speed. The head characteristics of the condensate and the heater drip pump, when required to operate at 60 cycles, can be adjusted by reducing the impeller diameters.

Procurement of suitable feedwater heaters, with their related accessory equipment and piping, was facilitated by tailoring the feed-heating cycle to fit available equipment. The engineers did this satisfactorily and, with the aid of WPB, obtained and installed all necessary equipment for initial operation with the turbine. Eighth-stage and tenth-stage closed-type heaters and the drip cooler were obtained from the canceled project for a new unit at Fisk Station of the Commonwealth Edison Co. The heaters were larger and of heavier construction than required, but were most acceptable because they were on hand and immediately available.

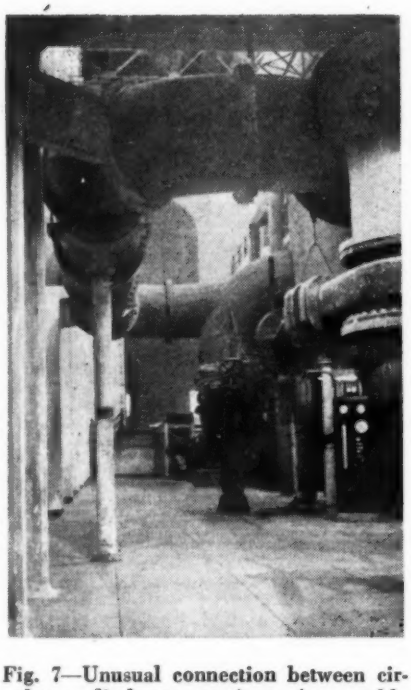


Fig. 7—Unusual connection between circulator discharge castings (to enable either pump to serve both halves of condenser) does not interfere with neat floor layout and adequate operating space

Also on hand at Fisk was the evaporator, one of two Griscom-Russell units, which because of the relatively smaller makeup requirements was readily adapted to Long Beach conditions. Foster Wheeler manufactured the thirteenth-stage deaerating heater and evaporator condenser from designs prepared for Venice station of the Union Electric Co. A Bowser lubricating-oil purifier, which was on hand, and the Davis atmospheric relief valve, under manufacture for Venice, were also purchased for unit 8R at Long Beach.

Piping materials, particularly valves, were most critical at the time, and presented the greatest procurement problem. Required valves were removed from existing piping in the station wherever they could be spared; others were obtained from canceled jobs and surplus stocks of companies from Maine to California. Under appropriate preferences granted by WPB, manufacturers supplied the remaining requirements.

Design and Construction

Design was prepared by Stone & Webster Engineering Corp. The same organization removed the two original units for the Treasury Department, constructed the new turbine support and feedwater-heating system, and supervised the turbine-generator and condenser installations, which were made by the respective manufacturers. E D Knobel was construction superintendent for Stone & Webster. All activities were under the general direction of H W Tice, manager of operation, Southern California Edison Co, Ltd. F G Philo is superintendent of steam generation, and R W Spencer represented the company at the job. W L Chadwick coordinated design and installation for the Southern California Edison Co.

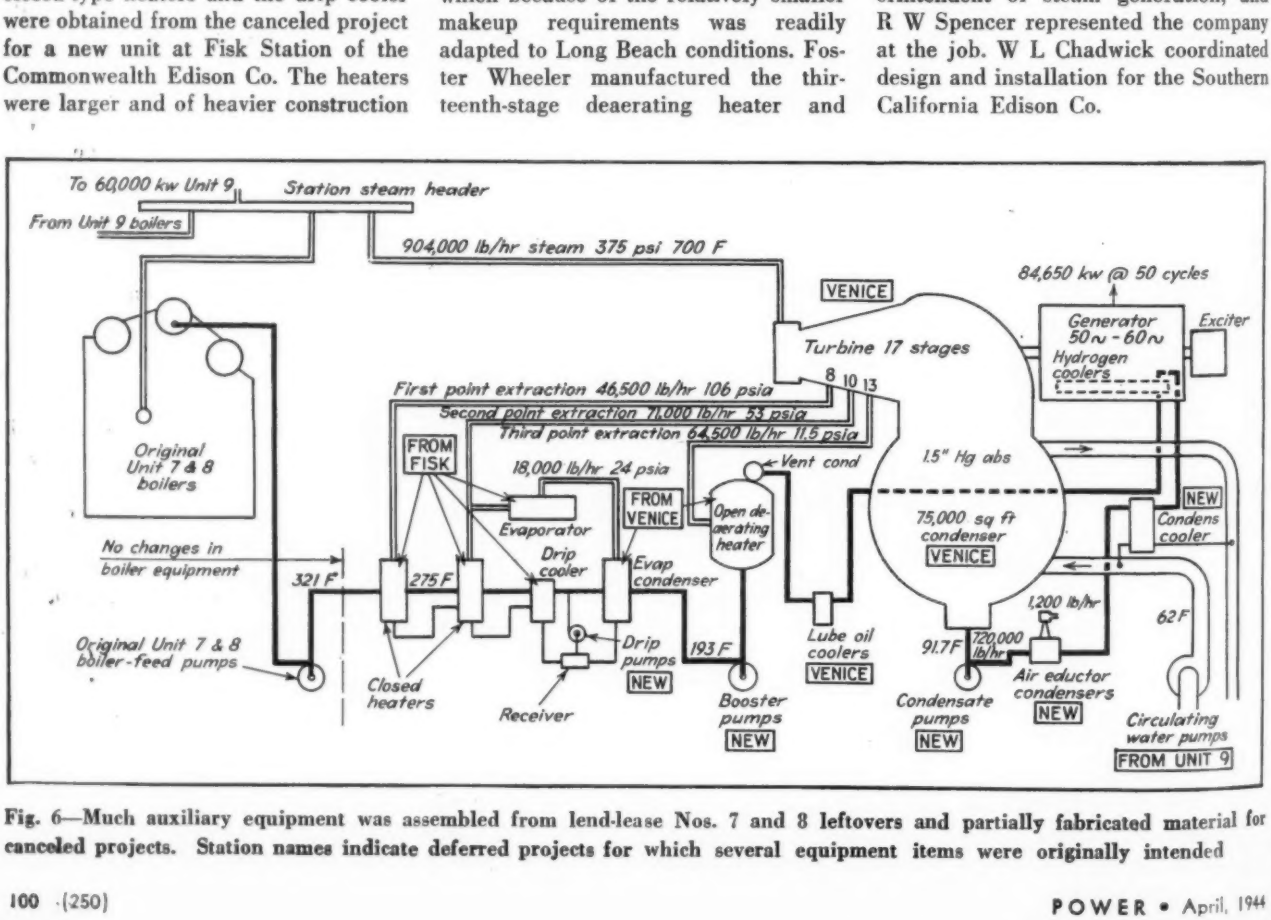


Fig. 6—Much auxiliary equipment was assembled from lend-lease Nos. 7 and 8 leftovers and partially fabricated material for canceled projects. Station names indicate deferred projects for which several equipment items were originally intended

When Do Journals Need a Lift?

Break-away friction in bearings is sometimes greater than applied starting torque can overcome. When this occurs in a motor, L W Riggs, General Electric Co, says that the answer is oil-pressure starting because it floats the shaft free

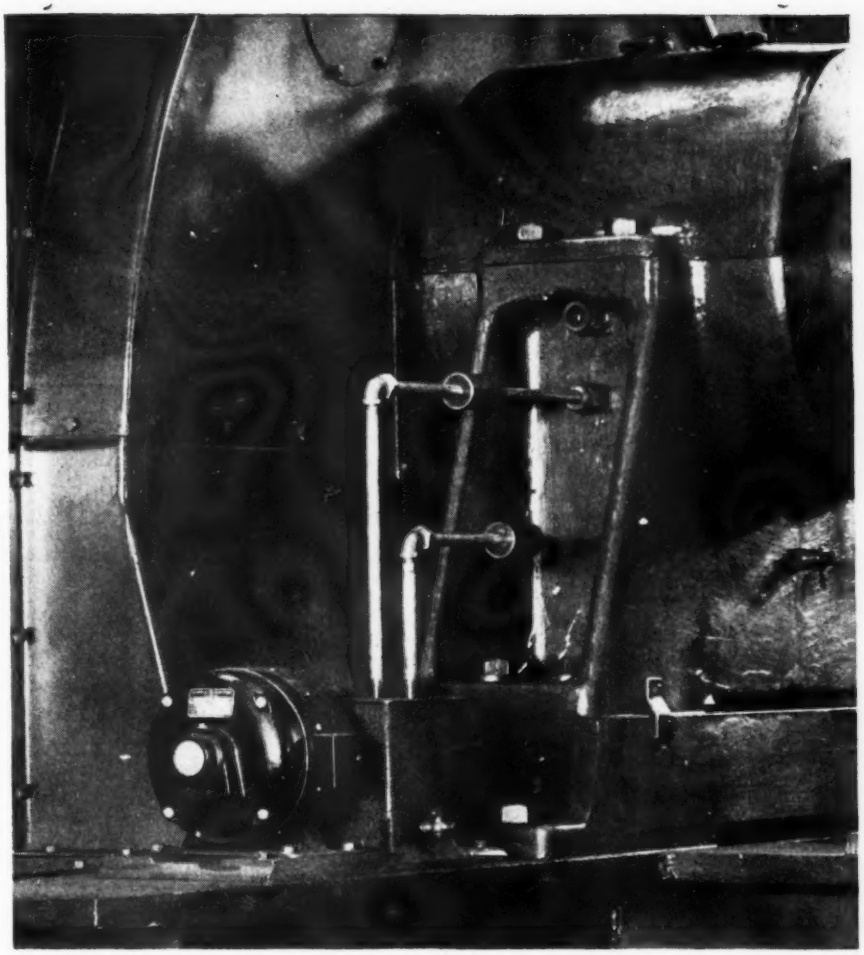


Fig. 1—A small motor and pump mounts on the bedplate adjacent to each bearing. Insulated couplings break the pipe circuit between bearing pedestal and bedplate

▶ ANYONE WHO HAS EVER WATCHED a mule tow a heavy barge along a canal while a nearby locomotive puffed to move a train of equal tonnage must have been impressed by the difference between fluid and dry friction. A shaft running on an oil film in a bearing encounters fluid friction, but the same shaft, at the instant of starting and before the oil film forms, encounters partially dry or greasy friction.

Obviously, less torque is needed to start a shaft if the oil film is formed beforehand. This can be done by pumping oil at high pressure under the journal, as in Fig. 1 and 2. Power required to drive the pump is amazingly small; a ¾-hp motor direct connected to a suitable gear pump easily lifts an 18-in. journal carrying a 50-ton load.

To lift such a load, using a pressure of 1000 psi under the journal, would presumably require pockets of 100 sq. in. in the babbitt, to which oil pressure is applied. Actually, pockets of only 10 to 20% of this size can be used because the oil seeps around the pocket edges forming a much larger pool to which pressure is applied. As soon as the shaft rises, say a couple of mils, size of the pool increases rapidly so that the pressure may fall off considerably and still support the journal.

Pressure Levels Out

Pressure stays fairly constant until the machine reaches speed and the pump is shut down. Back pressure from the rotating journal, Fig. 3, is usually 200 to 400 psi. Do not confuse this with the average pressure over the projected area of the bearing, which may be only a fraction of that amount. Since seepage around the pockets varies considerably on different bearings, it is easy to understand why the pressure required may not be the same for two bearings of a machine.

Although building up an oil film before starting does protect the bearing surfaces, this is not the real reason for oil-pressure starting. Witness the number of large machine bearings that operate successfully without oil pressure under the journals. These must start relatively dry and turn with metal-to-metal contact until oil ring carries oil to the journal.

Main reason for pressure is to enable a machine that has a light starting duty (synchronous condensers or mg sets) to start with a minimum voltage disturbance to the power system. Fluid friction requires less break-away torque, which can be developed at a lower applied voltage and, consequently, less kva.

It is important to remember that no saving in kva results unless a lower starting voltage is used, for, with a given voltage and frequency, starting current depends on the reactance of the machine's windings and this is, of course, unaffected by an oil film under the journals.

Makes Starting Easy

Time required to reach full speed on a low-voltage tap is greater than on a higher tap because the time varies inversely as the square of the applied voltage, assuming that the voltage is high enough to bring the machine to full speed.

One man can slowly turn the rotor of the largest two-bearing machines when oil-pressure starting is used, but it is inconceivable that he could crank such a rotor up to full speed against windage loss that increases as the cube of the speed. This illustrates why the starting voltage of oil-pressure-equipped machines must be higher than that neces-

sary merely to start rotation. It is usually high enough to permit starting a two-bearing machine even though one of the bearings has no oil pressure. Sets having a heavy flywheel supported by large bearings frequently employ oil pressure on only the larger bearings.

Most machines started on high-voltage taps, 50% and over, do not receive any appreciable benefit from oil pressure as more than sufficient torque is generally available to start without it.

Pump Design

Pressure gages are not usually employed. Pumps are positive displacement units and, if running, are pretty certain to produce sufficient pressure. Lift of journal occurs in one or two seconds from the time of starting the pumps. It can actually be felt by wedging the tip of a finger in the angle between the shaft and bearing pedestal nose.

At times, for remotely controlled or automatic substations, pressure relays provide a convenient signal to make sure that pumps are running. If a machine should not start, and other protective devices fail, the amortisseur winding will likely be damaged from over-heating if the power is left on long. In attended substations the operators can easily tell when the pumps start and when the machine rotates.

Fig. 3 shows that back pressure remains in the oil line even after pumps are shut down. This pressure can come from only one source: pumping action of the shaft on oil supplied to it by the oil rings or circulating pump which supplies oil through a cooler.

A plotted curve of bearing oil pressures shows that maximum pressure occurs under the journal midway between bearing ends gradually diminishing to zero toward each end of the bearing and up and around the shaft. If oil leaves this high-pressure area faster than it is supplied by the shaft, all pressures fall and journal may ride on the bearing metal. Serious leakage in the pressure line from an oil-pressure starting pump may drain oil away from this high-pressure area in the bearing after pump is shut down. Extensive bearing trouble may then occur.

Occasionally a pump will be found rotating slowly backward, running as a hydraulic motor under back oil pressure from the shaft. This is most likely to happen if the driving motor is equipped with ball bearings. Installing a check valve in the high-pressure line prevents leakage and reverse rotation of the pump.

When using a gage or relay to check this back pressure, conserve its life by using a snubber to damp out pressure variations that may occur with each revolution of the shaft.

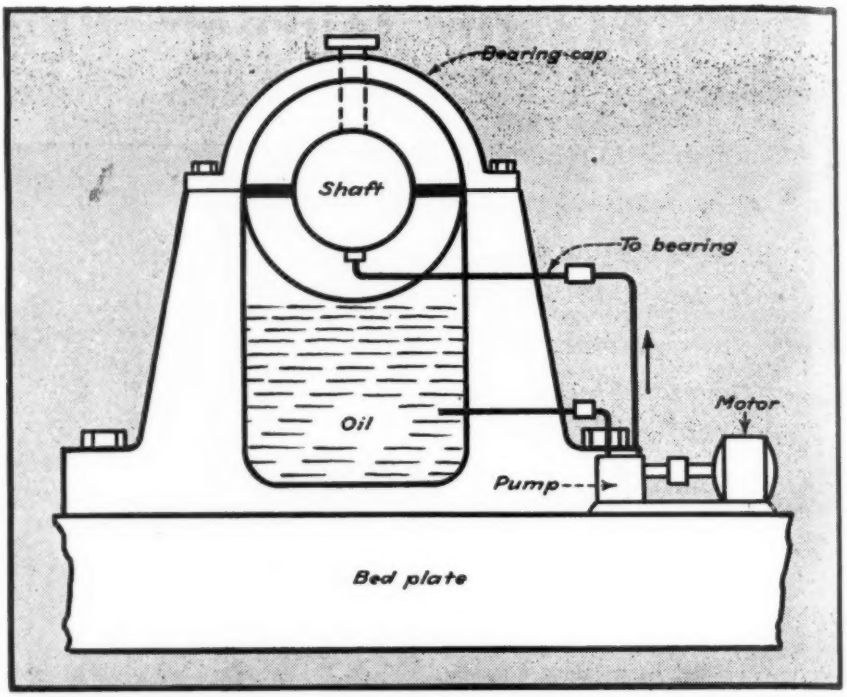


Fig. 2—Pump takes its suction from oil reservoir and discharges into lower bearing half. Narrow oil pocket extends to within several inches of each bearing end

Short Running Time

After the machine starts to roll and journal oil ring is carrying a full supply of lubricant to the bearing, the pressure pumps can be shut down. Continued operation after main unit reaches full speed serves no useful purpose but does shorten the pump's life.

Oil-pressure lift pumps are especially helpful during inspection of large machines. Barring the rotor over by hand becomes a simple matter if oil is supplied under the shaft; otherwise the operation is impossible. Work on the rotor such as testing coil connections, checking amortisseur winding and looking for loose bolts on fans becomes greatly simplified if the rotor can be moved to bring these parts up to small inspection doors cut in the housing.

Another job that requires moving the rotor is that of removing and replacing field poles on a revolving field machine. They can be slid off and on the rotor more easily if each pole is moved to its upper vertical position by turning the shaft as work progresses.

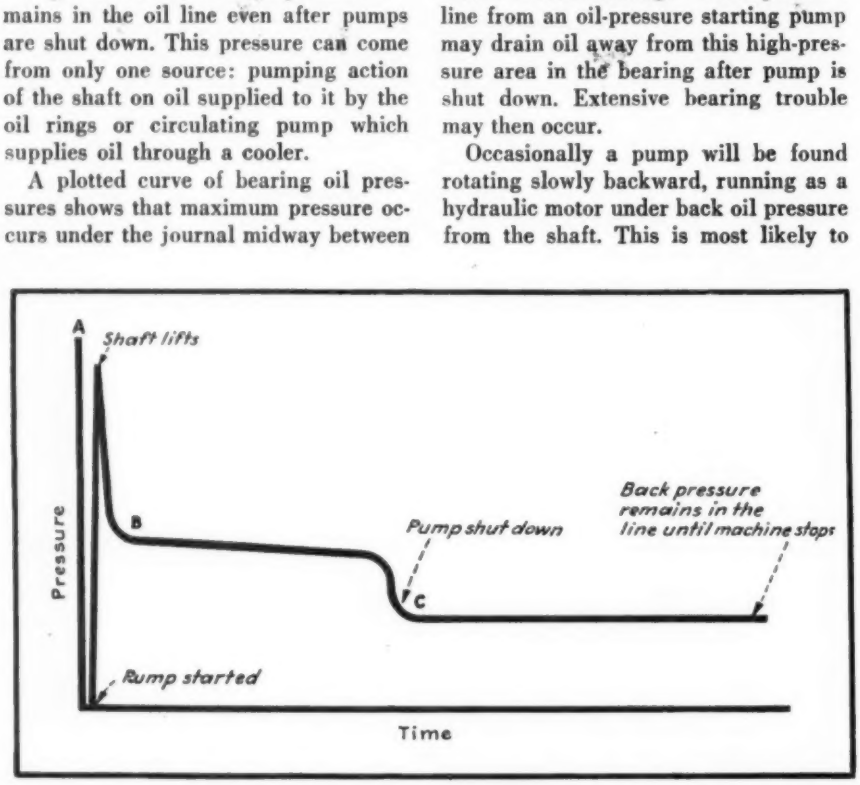


Fig. 3—Pressure builds up rapidly as at *A*. When shaft lifts, pressure falls to *B* where it continues until pump shuts down. Then, back pressure *C* from shaft remains

THE OPERATING ENGINEER

George Edwards *Advisory Editor*

PRACTICAL AIDS • MAINTENANCE HINTS • QUESTIONS — ANSWERS

PUBLISHED MONTHLY AS AN INTEGRAL PART OF POWER

For Tops in the Off-Season Job Of Inspection Try Year-Round Planning

You can keep compressor equipment shipshape without waste of time by fitting inspection's every move in with your other work. H A Boysen tells how in this step-by-step plan for overhauling an average 10x10-in. ammonia compressor*

ALLOWING MACHINES to run two or three years without a thorough going-over encourages self-deception—prevents your facing the full-capacity season with confidence. So, although there is no separate and distinct off-season, the operating engineer must find time each year to inspect his equipment thoroughly.

Especially on an important compressor-overhauling job does it pay to be painstaking. New men should receive sound training in rigging and safe handling of heavy compressor parts. If pistons are not removed carefully, considerable trouble, even damage to rings and cylinders, may result.

When taking a compressor off the line (machine shut down) close overhead discharge valve of that particular machine and open the bypass on compressor manifold. Then open the high-side pumpout valve (also on the manifold) just long enough to release high-pressure gas from the discharge line through the bypass valve into the system suction line. Close pumpout valve again and open crankcase pumpout valve a turn or two.

After these preliminary valve settings, start the compressor in the usual manner. Within a few minutes the oil gage will indicate a vacuum in the crankcase.

Gradually opening the high-side

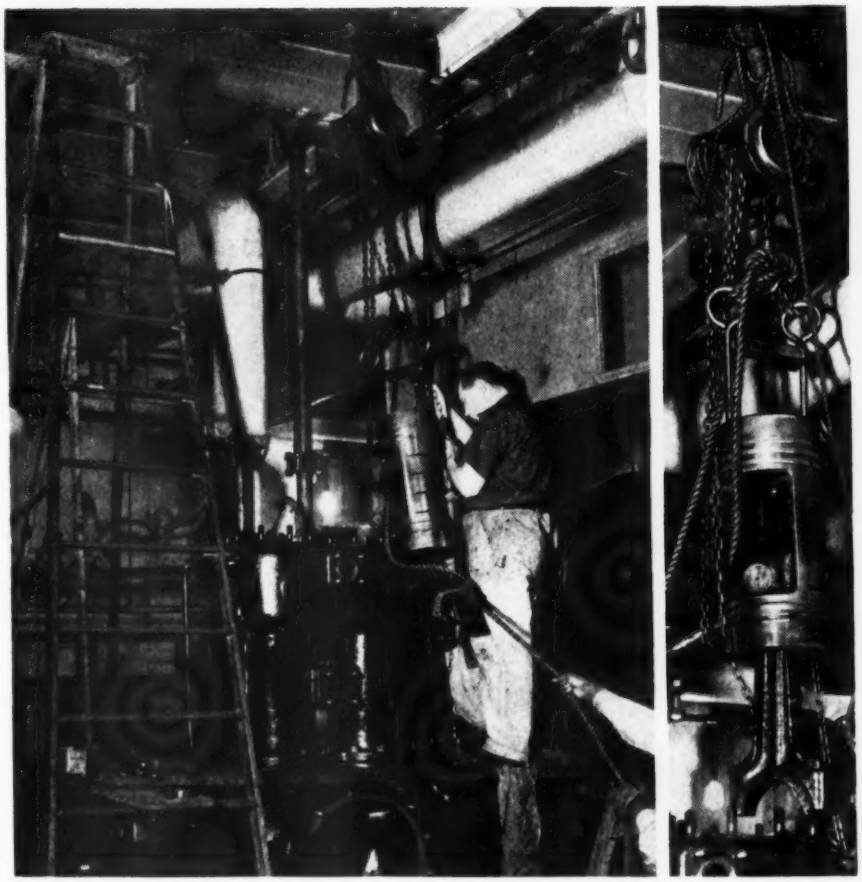


Fig. 1—Substantial overhead rigging lifts heavy pistons high enough to clear cylinder top. Wood spreader keeps the two eyebolts from bending (as shown in closeup at right). Lead rope holds piston clear of compressor. Stepladder, securely tied at both sides, and trestle support working platform

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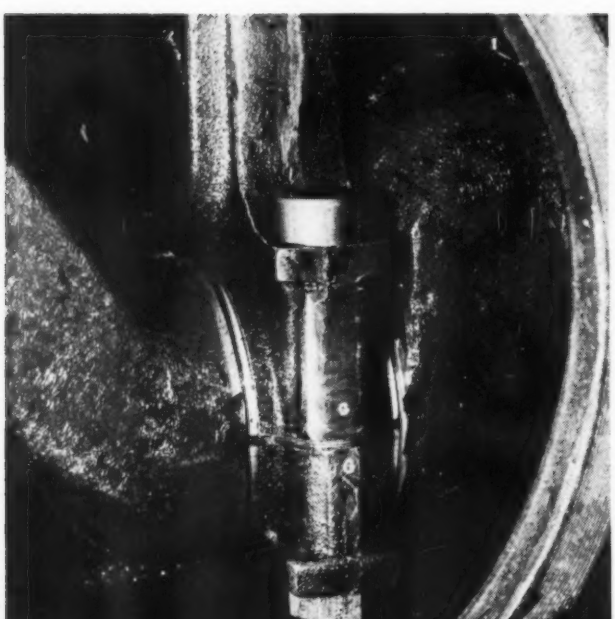


Fig. 2—(*above*) Punch marks on both the babbitt sections and connecting rod guard against wrong assembly and poorly fitted bearings

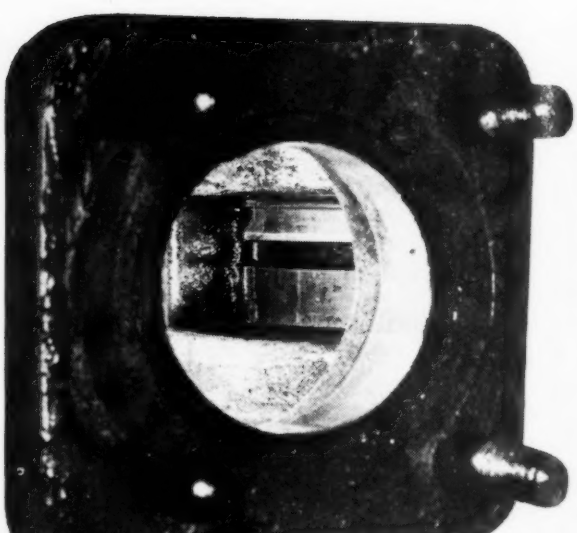
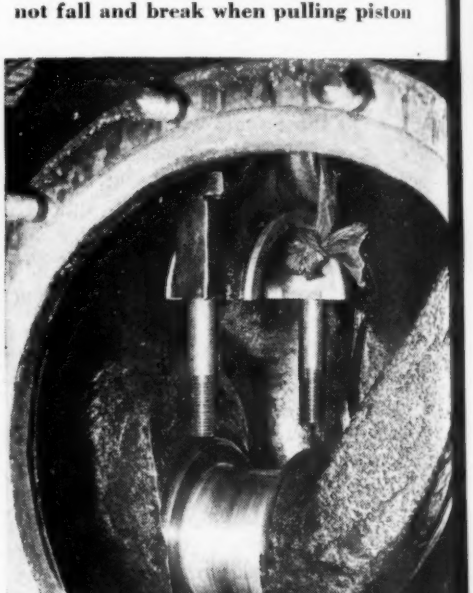


Fig. 5—Looking inside the suction port, watch oil-wiper ring as it passes. If joint ends protrude and catch on port edges, ease them back into their groove

Fig. 3—(*below*) Immediately after removing the connecting-rod cap, wire the spacer shims in their proper place. Lost shims cause delay

Fig. 4—If upper half of babbitt shell cannot be pulled from the connecting rod, tie it securely in place so it cannot fall and break when pulling piston



pumpout valve (on the manifold) puts a vacuum of about 25 in. on the discharge line up to the overhead valve and clears it of gas. All valve packing nuts and shaft stuffing boxes should be drawn up to prevent air being pulled into the system while under vacuum.

Experience shows that a high vacuum is not always obtainable, and it is essential to stop pumping regardless of the vacuum formed rather than to risk passing oil or pulling air into the system. Time required to pump out a machine should not exceed a maximum of 5 min.

As soon as the compressor stops, and not one second before, close the bypass quickly; small amounts of ammonia left in the compressor cylinder may be blown out to atmosphere by opening the valve or valves in compressor heads. Leave these valves open. Closing the overhead suction valve on compressor then isolates machine from the system for dismantling. Open the motor feed switch and remove its fuses.

Vacuum in the crankcase can be released through oil charging hose on the side of compressor, after which the large plate on crankcase can be removed and oil drained to allow remaining gas fumes to disperse. Then drain oil from crankcase and mount rigging (if not already done) in preparation for removing pistons.

Suspend chainfall or hoist from a substantial portable or permanent beam over the exact center of one of the cylinders and high enough to permit withdrawing the piston and connecting rod.

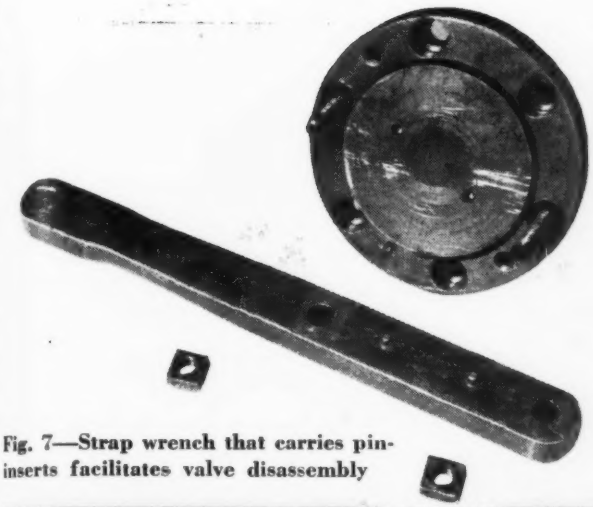


Fig. 7—Strap wrench that carries pin-inserts facilitates valve disassembly

Fig. 8—*(above)* Enlarged opening in spare cage *A* permits it to serve as a guide in place of working cage *B* when grinding valves *C*. This centers valve and fits it to its seat accurately

Fig. 6—*(left)* Check ring's working gap by slipping collar *A* over the piston and measure gap with a feeler gage. When gap approaches twice normal width, the ring's efficiency drops

plus eyebolts and sling, Fig. 1. Overhead rigging must be secured so that it will stand a vertical as well as a severe side-pull. Give attention also to the length of chain, which on some chain falls is frequently found to be too short to lower the piston to the floor after pulling it from the cylinder. If a rope sling must be used, allow for its length and never depend on a single-strand loop regardless of how good or how new the rope.

Use a 12- to 15-ft. stepladder to straddle the machine parts on one side of the compressor and position a trestle on the outboard side of the machine. To make a convenient platform for working in and around the compressor heads, lay a plank through the stepladder rungs; from this plank to each end of the trestle (front and rear of the compressor) lay other planks, placed inside ladder frame, as in Fig. 1.

As a safety precaution tie the stepladder at both sides and secure the planks so that they cannot slide. After getting a good whiff of ammonia in your nose and eyes, which is unavoidable when removing heads and other parts, it is reassuring to know you are on a substantial platform.

Removal of heads, springs and false heads from each cylinder now follows, causing no difficulty so far as mechanical procedure is concerned. It is well, however, to take a close look at the interior as soon as heads are lifted and springs removed. Seldom will the space above the cylinder look perfectly clean, but some machines may show excessive carbonized-oil deposits, and sometimes light spots appear as drops on both the false and main-cylinder heads that indicate lubricating-oil emulsification. Take immediate steps to remove any trace of moisture from the lubricating oil.

Next, loosen up crank bearings by unscrewing the connecting-rod bolts two or three turns. Then turn shaft so that the crank of the cylinder from which the piston is to be removed is on absolute upper dead center.

At this time, it is convenient to remove the suction valves after identifying them with punchmarks so that they can be replaced in the same location. Take special care not to lift valves until

all holding screws and lockwashers are removed from other valves in this particular piston. It is a heartbreaking experience to look for a missing lockwasher that dropped into the cylinder through an opening from which a valve was removed too soon. Screw eyebolts into the piston and insert a 2x4 spacer between them to prevent their pulling together under strain. Use a rope or chain loop between eyebolts and chainfall hook, Fig. 1.

Identify The Parts

Before removing crank-bearing cap put punchmarks on one side of the die-cast babbitt bearing halves and caps, Fig. 2, to forestall possible error in reassembly. Frequently the babbitt lining becomes loose from its cap, and although the manufacturer marks cap and rod, considerable extra work is required to determine just which way the lining must be inserted.

Just as important is it that none of the shims between cap and connecting rod be lost when lowering the bearing cap. Once the cap is removed tie the shims securely in place immediately, Fig. 3. Before removing top half of the babbitt bearing, pad the crankcase floor with rags or waste to prevent breakage if, in spite of reasonable care, the bearing should fall down. Some top sections are limited in their travel by the connecting rod bolts, but others fall right out when raising connecting rod only a fraction of an inch off its crank. If the top half feels secure and cannot be lifted out, tie it securely to its seat, Fig. 4, before pulling the piston to prevent it falling down when halfway up the cylinder.

Pull the piston with considerable care. It is definitely not a matter of merely pulling the chain hoist, with which you could probably apply sufficient tension to ruin the machine. As the chain hoist clicks, be sure to feel that the piston moves. If piston does not follow, stop pulling and relieve the tension immediately. Connecting rod will bind almost at the start if the crank is not on perfect dead center. Further hang-ups occur from piston binding if the pull is not perfectly straight. The piston stops dead if a ring has rotated into such a position that its ends expand into the suction opening of cylinder. Excess force exerted on the pulling end easily ruins the ring and may damage the cylinder wall. Remove backplate from opening, Fig. 5, and gently push the ring into its groove before proceeding with the pull.

As the rings emerge from cylinder end, notice how much they rotated from their original ideal position. Continue the lift until connecting rod clears top edge of the compressor, Fig. 1. After removing connecting-rod bolts and putting them with their nuts in the proper location (fore and aft) in the crankcase under the particular cylinder, attach a lead rope to end of connecting rod and pull piston clear of compressor while it is being lowered to wooden blocks placed on the floor.

Transfer top rigging above the center of other cylinder and pull its piston in a similar manner. Then remove suction filter, oil filter, oil pump and inspection covers affixed to the machine. With compressor completely dismantled except for the removal of crankshaft, spread all parts out on the floor, and give them a thorough and systematic inspection.

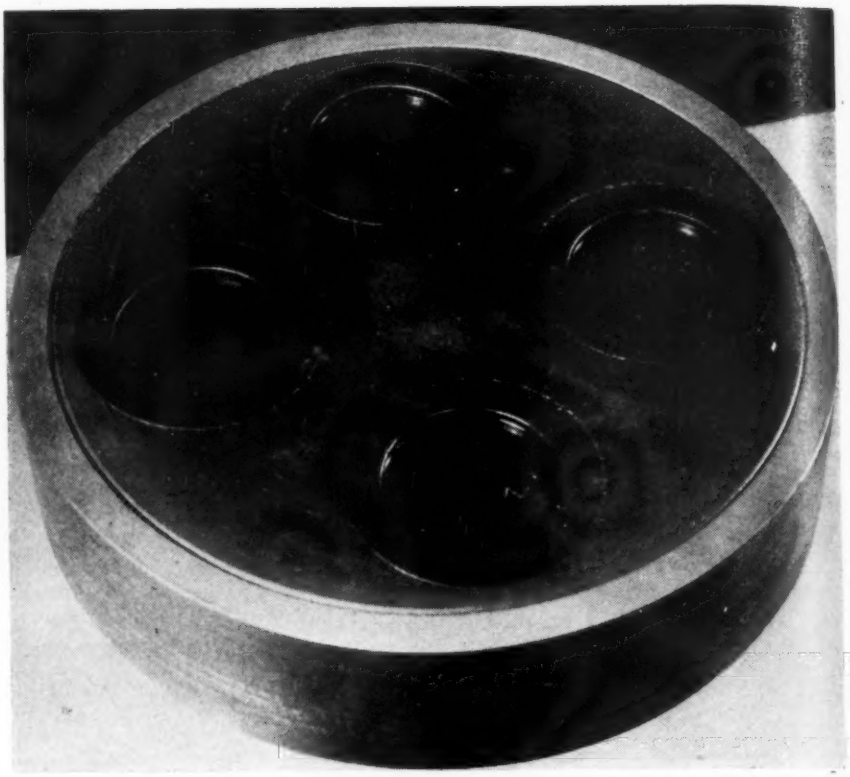


Fig. 9—After discharge valves are ground, false-head seat must be polished. Use grinding compound and lap to a positive, even contact around its periphery

Remove Grooving

Condition of cylinders and pistons is of major importance. A mirrorlike finish on the surfaces is indeed a gratifying sight for any engineer. It reflects infinite care and perfect supervision during operation. Out-of-roundness and slight grooving up to about 0.003 in. may be removed by honing whereas more extensive wear has to be corrected by reboring, which invariably requires installing new pistons. Even slight grooving must be worked smooth without fail because the trouble is progressive if not taken care of promptly.

Take a look at the cranks; they have a tendency to wear out of round. If caught in time, this fault can be corrected by light stoning. Fasten two stones opposite each other in a square frame and mount it on the crank. A handle on each side of the frame facilitates turning. Finished surface must be absolutely smooth.

Total crankshaft clearance inside the crankcase (end play) of nearly 0.025 in. should be nearly equally divided between shaft shoulders and main bearings. Even though the bearings did not run excessively warm, it is well to check this clearance. With a synchronous-motor drive the crankshaft can be forced endwise and current applied to the field until the motor rotor pulls into its magnetic center, or normal running position. If either end clearance is less than 0.004 in. at any point around the shaft shoulder, heating can be expected and readjustment usually has to be made.

Crankshaft bearings must be blued and checked on the crank if any grinding has been done; otherwise, it is usually sufficient to peel any high spots found on the babbitt and rechamfer the oil grooves. Take a good look at the overlapping sides of the babbitt that bear against the crank web. Any grooving or binding on the surfaces should be scraped clear.

(*Continued on page* 148)

How Much Power From Steam?

THE *steam rate* of a turbine is the weight of steam, in pounds per hour, that must flow through it for a net output of one horsepower, or one kilowatt. Consider a turbine generating 1000 hp (actual) at the coupling, connected to a generator delivering 700 kw (actual). If the total steam passing the throttle is 10,000 lb per hr, the steam rate is 10,000÷1000=10 lb per hphr, or 10,000÷700=14.3 lb per kwhr.

The *engine efficiency* of a turbine is a number (always less than 1) comparing its performance with that of a theoretically *perfect* turbine expanding steam from the same throttle pressure and temperature to the same backpressure. If the *actual* turbine has a steam rate of 14.3 lb per kwhr for conditions under which the perfect turbine would have a steam rate of 10.1 lb per kwhr, the engine efficiency is 10.1÷14.3=0.706, or 70.6%.

Whether the turbine is perfect or actual, the steam rate can be reduced by raising the throttle pressure, by reducing the back pressure, or both.

No single chart can cover all situations. The chart below (plotted from Mollier diagram data) applies to one set of conditions, but will give a very rough approximation of steam rate for typical actual turbines of medium size.

The long, flaring vertical pipe in the chart stands for a turbine expanding 100 lb of steam per hr from a throttle condition of 1485-psi gage and 1000 F (point 1) to a backpressure of 0.3 psi abs (point 16). This idealized (but not perfect) machine reduces the pressure in a series of steps, or stages, such that each step produces 1 kw net generator output.

In plotting this chart it was assumed that each stage had an efficiency of 70% (70% of a perfect stage operating through the same range). Initial pressure and temperature at point 1 were adjusted to bring point 11 exactly to dry saturated steam at atmospheric pressure.

An actual turbine may be looked upon as a piece of this machine. If we consider only the section from point 4 to point 10, it becomes a turbine of 10−4 =6 stages, expanding 100 lb of steam per hr from 500-psi gage and 760 F to 13-psi gage. The stage efficiency is still 70%. Final steam temperature is 290 F. Net kilowatts generated are equal to the number of expansion steps, or 6 kw. Remember that this is for a flow of 100 lb steam per hr. If actual flow of steam is 20,000 lb per hr, the power produced will be 200×6=1200 kw.

The steam rate is easily figured. Since 6 kw requires 100 lb of steam per hr, steam per kwhr will be 100÷6=16.7 lb.

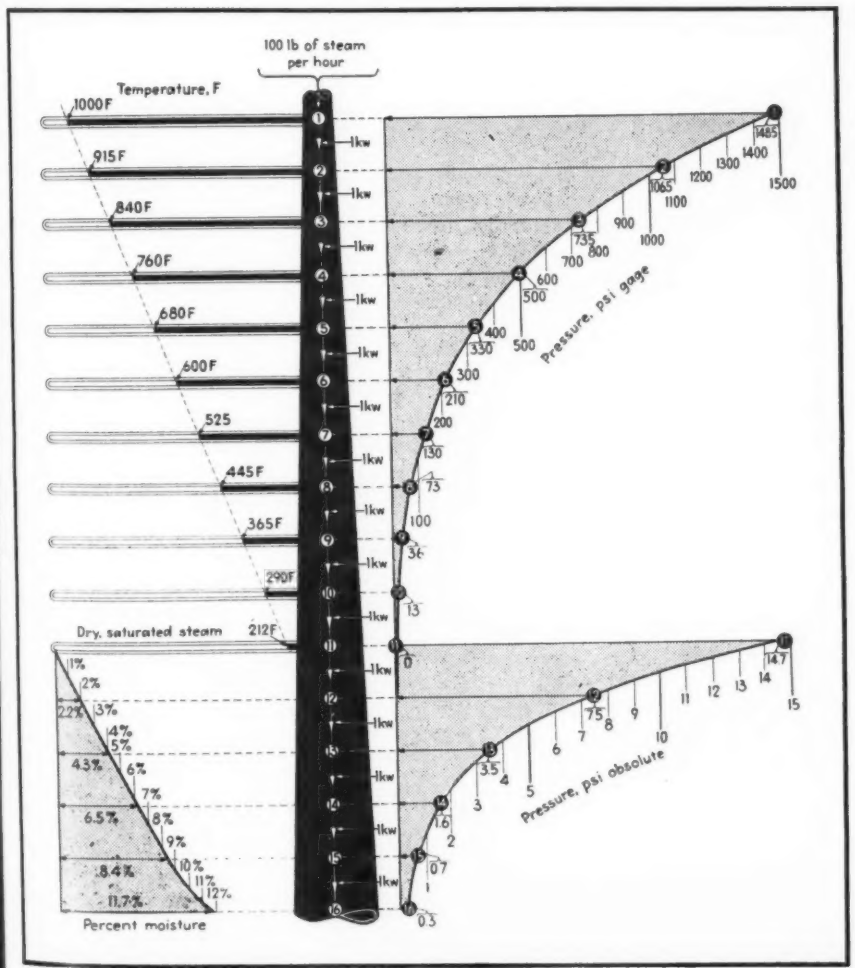
Problem Worked Out

Problem: A non-bleeding backpressure turbine is to exhaust 18,000 lb of steam per hr to process at 36-psi gage and 365 F. What must be initial steam condition to generate 1250 kw as a by-product?

Required kilowatts per 100 lb steam are 1250÷180=6.95 kw. Therefore, count up 7 steps from the specified backpressure (point 9) to point 2, where indicated throttle condition is 915 F and 1065-psi gage.

Note carefully that efficiency conditions in actual turbines may differ considerably from those of the chart—also that stage efficiencies are normally less in the high-pressure stages, particularly for small turbines.

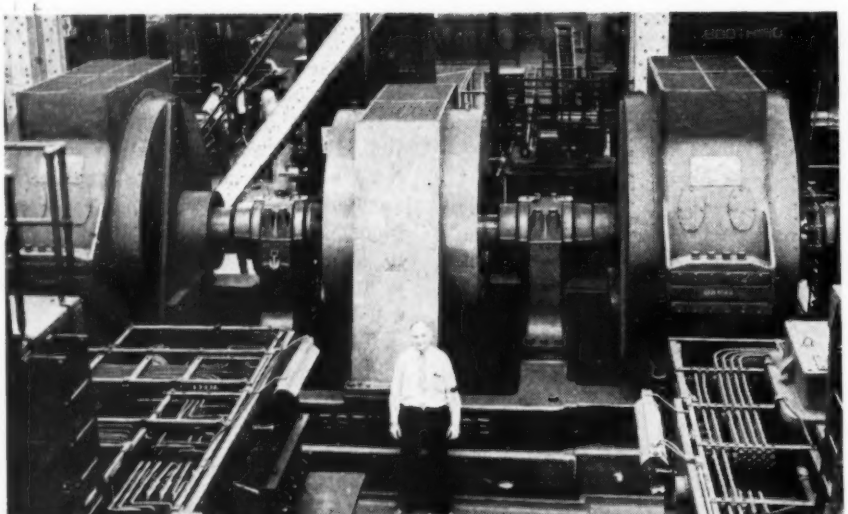
Readers seeking more accurate and detailed methods of estimating turbine performance for all commercial conditions should consult *Modern Turbines* by Newman, Keller, Wales and Lyons, just published by John Wiley and Sons, New York. This concise book is ideally suited to the power engineer who is starting to plan his postwar steam conditions and power-process hookup.



Expansion of 100 lb steam per hr from any serially numbered point to any other point with a larger serial number will produce power in kilowatts equal to the larger serial number minus the smaller. Chart assumes that each stage expands steam from one serial number to the next with a stage efficiency of 70%, and that all energy waste is returned to steam as heat

Chart by PMI Swain

PRACTICAL AIDS TO OPERATION



25-Cycle Generators for 60 Cycles

A LARGE INCREASE IN ORDERS made necessary more 60-cycle generator capacity for testing power transformers at our Sharon works. Floor space was not available for additional equipment, delivery time for a new generator was too long, and demand for 25-cycle transformers had decreased to where all our 25-cycle generator capacity was not needed. This led to studying how to revamp a 3-unit motor-generator set of two 4300-kva 2200-v 3-phase 25-cycle generators driven by a 4300-hp 6600-v, 3-phase 60-cycle 300-rpm synchronous motor.

We found that such a change in the machines would reduce delivery time, and save floor space, money and critical materials. In this study we considered effects of increased speed on rotating parts, how to reconnect the generator windings and keep the voltage within existing insulation strength, and how to revamp the bus structure and switching equipment to handle increased generator capacity.

By reconnecting the generator-stator windings, all coils in parallel, and revamping the polepieces, generator speed could be increased from 300 to 720 rpm and rating from 4300 to 10,500 kva, 2600 v, 3 phase 60 cycles. The motor was rebuilt for 6600-v, 3-phase 60-cycle 720-rpm operation, which increased its rating from 4300 to 7500 hp. Motor horsepower is only a little over 33% of generator kva rating. This can be so because the generators supply transformer test loads that have a power factor from 0.5 to 0.2.

The revamped machines work satisfactorily, and using them saves floor space, at least six months in making the equipment available, a large amount of critical material, and about $40,000 in new equipment.

Sharon, Pa. C W DIEHL
Westinghouse Elec & Mfg Co

Little Leaks Add Up to Big Ones

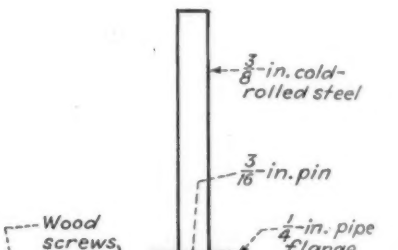
WHEN WE LOOK for ways and means to reduce operating costs too many of us expect to find large losses glaring at us, and overlook the little leaks that during a year amount to an astonishing figure. Through a $\frac{1}{16}$-in. hole in one month over one-quarter million cubic feet of compressed air flows to waste at 100 psi. It does not require many small leaks to equal that through a $\frac{1}{16}$-in. hole, which represents a loss of approximately $300 per year. Similar examples can be cited for water, gas, steam and electricity, even though the annual cost may not be quite so high.

Many electricians believe that as long as a short circuit does not occur, a circuit is fully insulated. Nevertheless, rewiring one plant where conditions were wet and conductor insulation was in bad shape reduced the power load over 120 kw. This is unusual, but it does emphasize the possible loss through electrical conductor insulation.

When air or water is used in process for cleaning or other purposes, particularly in a lot of small applications, watch the valves closely. Workmen leave them open, they leak or other waste develops. As already mentioned, small leaks that go unnoticed by workmen, soon cause a greater loss than the cost of making the repair several times.

Frequently carelessness causes these losses, but more often it is failure to appreciate the magnitude of small losses over long periods. In maintenance work if small leaks are properly taken care of there will be no large ones to worry about.

Chicago, Ill. J B MULLINS



Homemade Valve Grinder Turns the Trick

DIAGRAM SHOWS a pump-valve grinding jig that I made, which does a good job. From a hardwood board I cut a disk slightly larger than the valves to be ground and bored a $\frac{3}{8}$-in. hole through its center. I then drilled a $\frac{3}{8}$-in. hole through a small flange and fastened it to the wood disk so that the hole in one lined with that in the other. For a shaft to operate the grinder, I use a piece of $\frac{3}{8}$-in. round steel with a $\frac{3}{16}$-in. hole bored through it, about 1.5 in. from one end. A pin through the hole, fitted into a slot in the flange top, drives the grinder. A piece of emery cloth held to the face of the disk with wood screws completed the job.

In operation, grinder stem is put in

an electric drill chuck, the grinding surface placed on the valve seat and the drill started. The flexible connection formed by the pin in the disk slot, insures that the grinding surface will always make even contact with the valve seat and will not be tipped by any slight movement of the drill from the vertical. If the valve seats are in bad condition, initial grinding is done with coarse emery cloth and finishing with a fine grade.

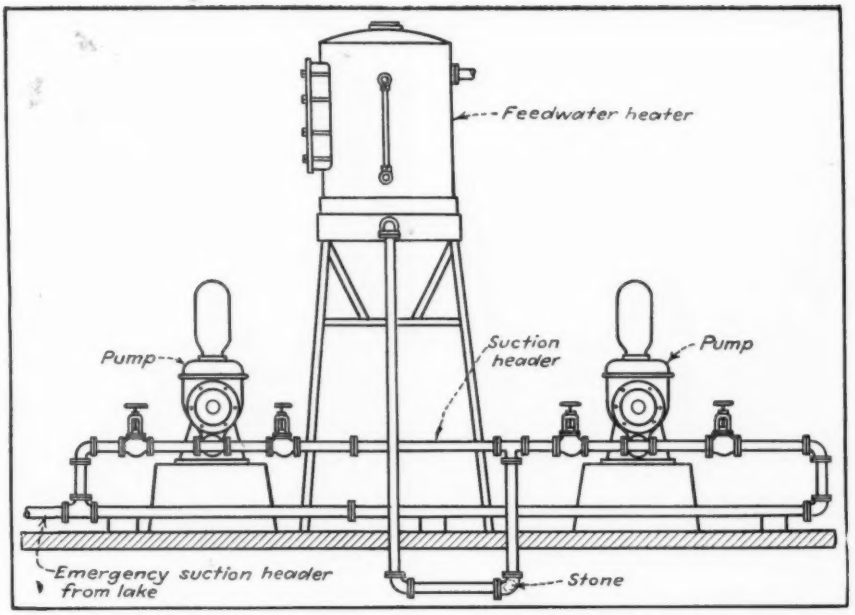
Baltimore, Md. CHARLES W PARKS

Rock in Suction Line Makes Pumping Noisy

IN OUR PLANT, noisy operation of a pair of simplex boiler-feed pumps gave us trouble. They took their suction from a feedwater heater, located to give about 15-ft suction head. For this reason, the noise did not seem to be caused by the pumps becoming vaporbound on the water end.

As shown in the diagram, the suction pipe from the bottom of the feedwater heater runs under the floor and comes up vertically to a suction header to which the pumps connect.

After trying everything we could think of to correct the trouble, we dismantled the suction piping to see whether it was obstructed, and found a large stone in the vertical section of the pipe below the suction header. Under certain flow conditions it would be carried up and strike the tees between the two pumps. Then it would fall back and strike the elbow at the pipe's lower end. Pieces of the rock chipped off, got into the pumps and scored pistons and cylinder liners. In addition, pounding of the rock, plus restricted flow that caused pounding of the pumps, made plenty of noise and vibration. Trouble ceased when we removed the rock.



Precott, Ore. J A OBERSTALLER

Built Carriages That Speed Drum Handling

TO REDUCE WORK of moving drums of lubricating oil and chemicals in plant yard and on loading platforms, the welder of one company built the handy carriages in the photos.

Using odd lengths of salvaged steel rod, the carriage consists essentially of a 4-wheeled framework, which is pivoted on a horizontal axle, and a bed framework, which accommodates a full 50-gal drum, Fig. 1. The bed frame may be inclined at any angle and held there by notched bar *B*, which engages a small latch on upper part of frame. Short extension-handle *H* gives operator added leverage, especially when the bed frame is almost vertical, to allow its lower bar to slip under the edge of a full drum for loading, as in Fig. 1.

Each carriage supported by four wooden wheels with broad treads easily

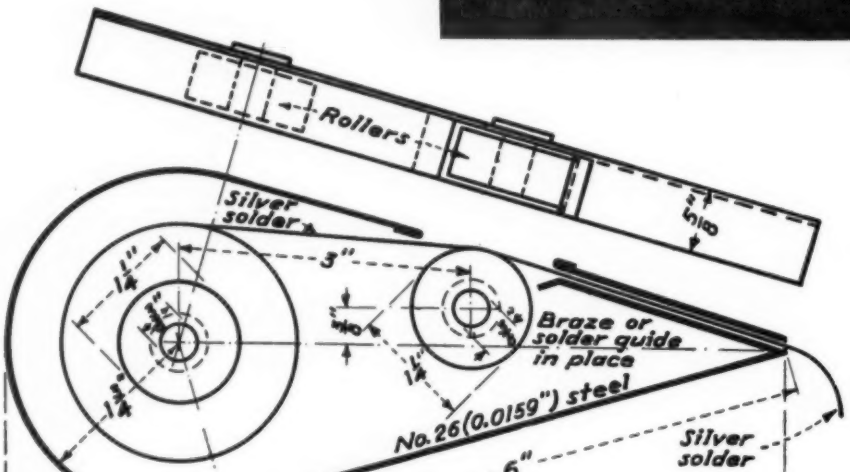
handles oil drums on irregular ground or rough flooring. Fig. 2. Equally serviceable metal wheels are cut from discarded 6-in. pipe couplings into sections, and each supports a bearing to fit the axle.

By building a few rough jigs, the welder quickly and cheaply made a number of these handy carriages for different plant departments. Labor saving has paid several times for the relatively inexpensive materials and time of the welder.

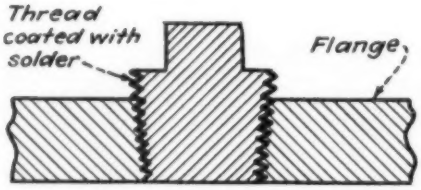
Pomona, Calif. G M WILSON

Easily Handled Dispenser Saves Silver Solder

THE EASY-TO-MAKE silver-solder dispenser in the photo and drawing, suggested by John Antkowick, a workman at General Electric's Schenectady works, simplifies feeding of ribbon solder in silver-alloy brazing work and prevents waste. The dispenser, a flat metal case, contains two red-fiber rollers, one in the circular portion and another near the point. A roll of silver solder, placed on the rear roller is thumb-fed over the front roller and out the point of the dispenser through a slot in the end of the case, as illustrated.



Previously, the operator would cut a piece of solder about 2 ft long. As this strip became shorter it got too hot to handle and the workman dropped it and got another piece. Now, the dispenser can be loaded quickly with sufficient solder for several brazes, and the operator can keep his hand far enough from the work to avoid burning it.



Solder Stops Leak Around Pipe Plug

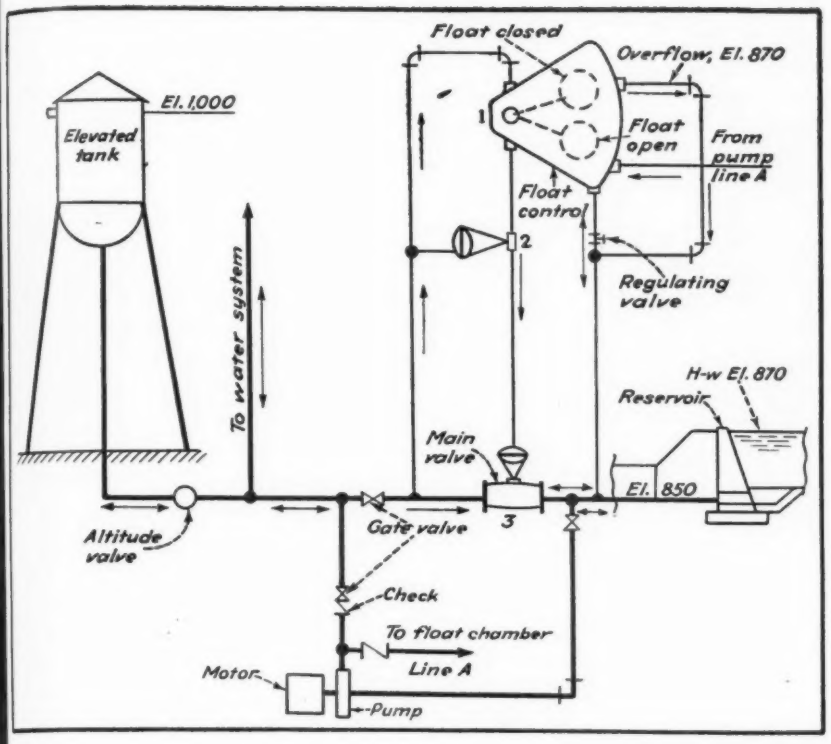
A ¾-IN. PIPE PLUG screwed into a 300-psi flange leaked steam even after we tried all the conventional ways of stopping such leaks. Coating the plug with white lead and other pastes supposed to make threads tight did no good. We finally tinned the thread with solder and tightened the plug home. This stopped the leak permanently. Maybe some other engineer will find this little trick helpful on a persistent leak.

Great Neck, N. Y. S M ELONKA

Valved for Dual Pumping System

A CLOSED WATER SYSTEM with two elevated tanks about one mile apart is supplied by high-head pumps four miles away. The elevated tanks at opposite ends of the system equalize supply and demand. At one of the tanks, a ground reservoir with motor-driven pumps provides a reserve water supply. It was required that the elevated tank be kept as nearly full as possible, and that the reservoir fill only after the elevated tank was full.

This was done by a system of pressure- and float-operated valves, shown in the sketch. Valves 2 and 3 are spring closed and opened by elevated-tank pressure. Water-level closes float-operated valve 1 when reservoir is full. Assume that reservoir and tank are half



full. Under this condition float-valve 1 is open to apply tank pressure to valve 3 and open it. However, the tank must be within at least two feet of being full, before pressure on valve 2 is sufficient to open it; so 2 and 3 remain closed. Then any excess water coming into the system goes to the tank until it is nearly full.

When pressure on 2 is sufficient to open it, thus applying pressure to open valve 3, water flows into the reservoir. When it fills, float-valve 1 closes off tank pressure to 3, and it closes. Then all excess water in the system goes to the tank until it is filled, and this closes the altitude valve.

During emergencies, water is pumped from the reservoir by a motor-driven pump, as shown. This pump bypasses valve 3 in the line between reservoir and tank. When the pump starts and lowers reservoir level, the float valve opens. Dynamic head on the discharge of the pump builds up pressure in the line and valves 2 and 3 would also open, causing the water to short circuit and the controls to hunt. To prevent this, a connection from the pump discharge into the float chamber keeps it full and valve 3 closed as long as the pump runs.

Normally, the reservoir is kept full and is not drawn from until the elevated-tank water level gets low. Then the pump is started manually to supply water from the reservoir to the system and elevated tank.

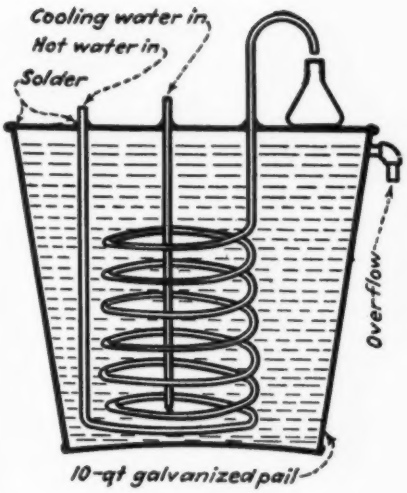
Franklin, Ind. IRA A BUTCHER

Portable Heat Exchanger Cools Boiler Water

WE CONSTRUCTED the small heat exchanger in the sketch to cool boiler water samples. Rather than make a permanent one from pipe and fittings for each boiler, we made a portable unit from a 10-qt galvanized pail.

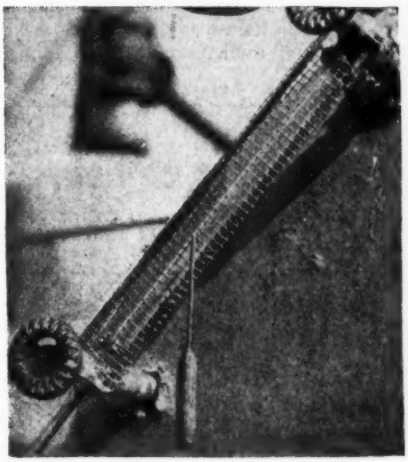
We made the coil from 25 ft of ⅛ in. OD copper tubing coiled to form an 8-in. spiral. Free ends of tubing were long enough to extend above pail rim with the coil extending down near its bottom. A ½-in. galvanized pipe elbow and two nipples soldered into the side of pail near upper rim served for cooling-water overflow. Cooling water enters through a ⅛-in. pipe extending well down into the pail. This small inlet pipe and fairly large overflow prevents any appreciable water pressure building up in the pail.

Next, we cut a round disk from galvanized sheet steel to fit across pail rim, and drilled holes in it to fit the tubing outlets. After slipping the cover in place we soldered it around the rim and at all pipe exits. We bent sampling tube outlet into a gooseneck to discharge into



the sampling flask. To take oxygen samples, a rubber hose is slipped over the gooseneck and connects to a flask by tubing. Connections to sampling and cooling-water inlets can suit conditions.

Philadelphia, Pa. R O SPENCER



Red Pointer Indicates Boiler-Water Level

A LARGE CALIFORNIA COMPANY makes it easier for attendants to keep track of water level in their boiler by a simple level indicator easily fastened over each gage glass, shown in photo. A small piece of ¼-in. wire-mesh cloth is attached to the gage glass its full length. A small hook, made of wire several inches long with a short wooden handle, serves as the indicator. Painted a bright red, indicator is hooked to the screen at the desired water level. The boilerman can then easily see the level to maintain and make adjustments accordingly. When blowing down the boilers, indicator shows the level to which the water must be returned when blowdown is completed.

Pomona, Calif. G M WILSON

READERS' PROBLEMS

Questions From Our Readers

Question 1

Should Blowers Be Shut Down?

When some firemen coal hand-fired boilers, using forced draft and burning bituminous run-of-mine coal, they leave the forced-draft blower running while firing doors are open even though flames come out and threaten to singe them.

They explain that shutting the blower down while refueling permits the fine coal to cake on top of the fire bed, which prevents free flow of air when the blower is restarted and lowers boiler performance.

As coaling takes only about 20 sec. at each door their explanation appears grossly exaggerated. In plants using natural draft, be it ever so strong, there is no such complaint although when firing door is open stack draft has no effect on fuel bed.

Is there any basis for this reasoning on forced draft? If so, what convenient method can be used to adjust the air pressure, while doors are open so that flames do not emerge, and yet prevent fuel surface from caking? Is this just an excuse for not taking the trouble to shut the blower down? Can we overcome this by installing a blower-motor control switch on boiler front?—*AAB*

Question 2

How Do You Pack Valve Stems?

How often can the packing gland on a valve stem be tightened before installing new packing? Continued tightening stops leakage but it makes the valve difficult to operate and does in time wear the stem until it leaks continually. How does this affect regulating valve operation?

When adding so-called coil packing should you cut it into individual rings or can you wind it around the stem until the gland is filled? What material serves best for oil, steam or water, or can the same material be used for all three? I find it quite difficult to hold transil oil with the common varieties of stem packing. On several occasions the gland follower was broken by overtightening.—*CS*

SUITABLE ANSWERS from readers will be paid for if space is available for publication. Answers that are accompanied by rough drawings or photographs will command additional pay.

Answers to Feb. Question 1

How About an Air-Conditioning System?

OUR CONTROL ROOM *gets extremely hot in summer from heat radiated by numerous resistors and indicating lamps.*

Since there is sufficient water to operate the vacuum jets on a refrigerating unit, will water serve this purpose as well as steam? Water pressure at jet would be low (approximately 5 psi) but discharge would have a free drop of 45 ft through the tail pipe. Would this arrangement provide sufficient vacuum in a spray evaporator tank using water as the refrigerant?

The room is 60 ft wide, 100 ft long and 12 ft high. Inlet and exhaust fans now installed supply five air changes per hour; with incoming air at 80 F room temperature averages 110 F—HF

Use Mechanical Unit

I ADVISE HF not to attempt using water instead of a steam jet because size and cost of equipment would be prohibitive.

Since refrigeration is needed only during warm and hot weather, I suggest a motor-driven Freon compressor. Take into consideration the fact that there will be a 5-month lay-up period each year when the plant is shut down. A steam jet evaporative system is advisable only when the plant is used almost continuously.

If Freon cannot be obtained, use any refrigerant with similar characteristics (one for which you can use light-weight piping, such as brass) and eventually when Freon is available, change over to it.

Brooklyn, N. Y. A J WENIG

Evaporative Cooling Does the Trick

UNDOUBTEDLY HF FEELS that 5 psi at the jet, with a 45-ft drop through the tail pipe gives sufficient pressure drop across a nozzle to permit substituting water for steam in jet refrigeration. However, one of the main purposes of the primary jet in a system of this sort is to remove the large volume of evaporated water from the spray tank and compress and transfer it to the condenser.

Available formulas show that a water jet does not have sufficient velocity to induce flow of a large volume of water vapor. Moreover, an attempt to take advantage of the 45-ft drop in tail pipe would result in cavitation and consequent damage to the nozzle and other equipment.

With the large quantity of water available, there are a number of alternatives. A temperature of 90 F can be maintained in the control room under certain favorable conditions.

If water is available at 55 F, as during a large part of the season, the five air changes per hour, or 6000 cfm. would be sufficient. Assuming the outside air to be 80 F and 65 F dry- and wet-bulb respectively, and using a 2-compartment spray chamber with a total of 2 lb of water per lb of air, the air leaves the sprays at 60 F db and 58 F wb. This maintains a 90 F db temperature in the control room, which is fairly satisfactory if the room's moisture load is not too great. By increasing the quantity of air we could, of course, obtain much more satisfactory conditions in the control room.

At other, less favorable times of the year, water might be available at only 65 F. With the same outside air conditions, and using water sprays the best that could be expected, using evaporative cooling, is air leaving the spray at 68 F db and 65 F wb.

Using the same quantity of air would produce an inside dry-bulb temperature of 98 F. Evaporative cooling would be

(*Continued on page* 162)

Answers to Feb. Question 2

Can We Prevent Receiver Drain Freezing?

WE USE COMPRESSED AIR *almost entirely to operate our heating system thermostatic controls—all located inside warm buildings. The main air receiver is located outside and we have considerable trouble with the drain line freezing in cold weather. How can we prevent this trouble?*

Can we introduce alcohol or other anti-freeze into the receiver for this purpose? If so, will it separate out in filters if its presence is undesirable in certain air uses? Capacity of our system is 200 *cfm.—DLW.*

Build a Heated Inclosure

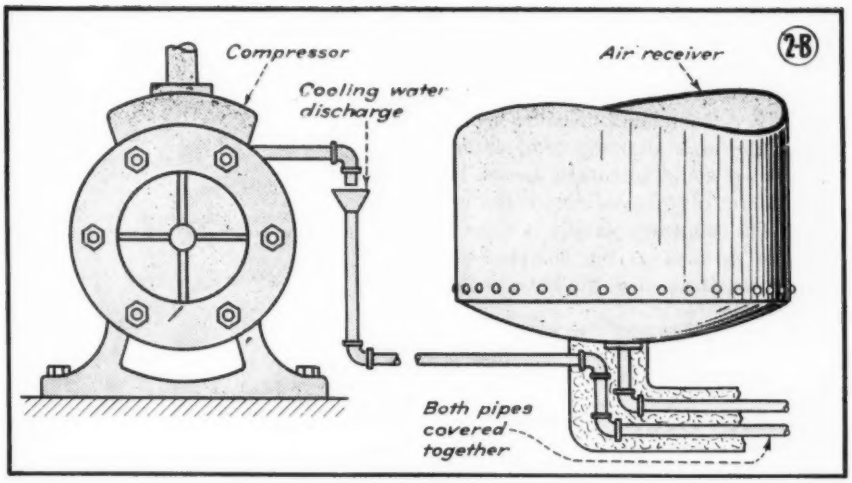
PERHAPS DLW's most practical solution is either to move the air tank to a warmer location or to build a shed or similar construction around it, and by suitable means prevent its temperature dropping below freezing point.

Naturally, steps taken depend upon which remedy is used. The first appears most logical since it should not be much of a job or take much time to set the tank inside, assuming the time, space and help are available.

Second method is also quite practicable. Building a shed large enough to house the tank could be reasonably cheap. Method of obtaining heat depends upon existing conditions as in sketch 2-A. The radiator is equipped with a pneumatic thermostat while an electric-heating element can be controlled by a direct-acting electric thermostat.

Alcohol is suitable in automobile radiators but not in compressed-air systems. It corrodes the system and may cause an explosion.

Buffalo, N. Y. T B BREEN



Use Cooling Water For Heating

INJECTING ALCOHOL into an air line or receiver is dangerous. I know of an instance when several hundred feet of 4-in. air line burst because alcohol vapor formed a mixture that exploded.

Instead I suggest piping the warm water of the overflow from compressor along the blowdown pipe and covering the two snugly together, sketch 2-B, being careful to maintain a sloping grade on the pipes for good drainage.

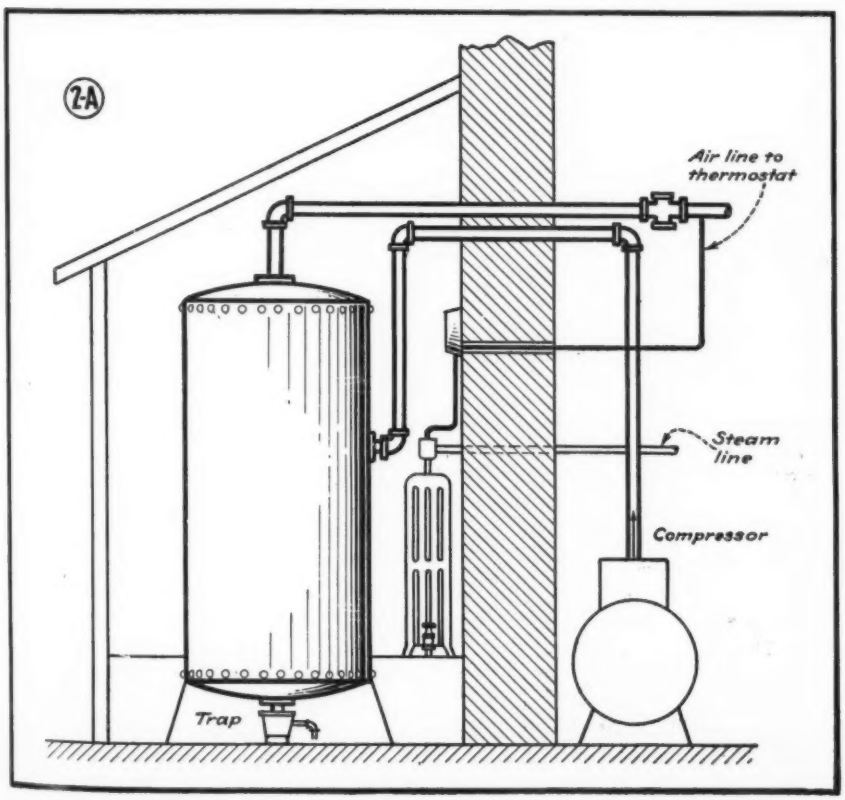
Brandon, Manitoba W A WYBORN

Install Aftercooler And Trap

FIRST AND MOST DESIRABLE REMEDY is for DLW to install an aftercooler, complete with separator and automatic condensate trap, inside the building between the air compressor and receiver. The aftercooler, when supplied with water at as low a temperature as possible, will condense most, if not all, entrained oil and moisture, which will be deposited in the bottom of the separator and automatically discharged to the sewer by the condensate trap. An aftercooler, complete with separator and condensate trap for a 200-cfm compressor, costs $310.00. It improves the operation of the thermostatic controls by delivering clean, dry air.

A second but less desirable solution is the installation of a vaporizer in the discharge line between the compressor and air receiver. This device injects a small quantity of non-explosive gas which joins with the water in the air receiver and prevents freezing. Such an installation costs $250.00. It is not advisable to use alcohol in the air receiver because of the explosion hazard.

Freezing will probably not be en-



countered in the air receiver while the compressor is in operation unless the machine is much larger than the load and consequently pumps air infrequently. Accumulated moisture remaining in the tank after the compressor is shut down would, of course, freeze. Possibly more frequent draining is the solution. The moisture should always be drained as soon as the compressor is shut down. Drain line should be as short as possible.

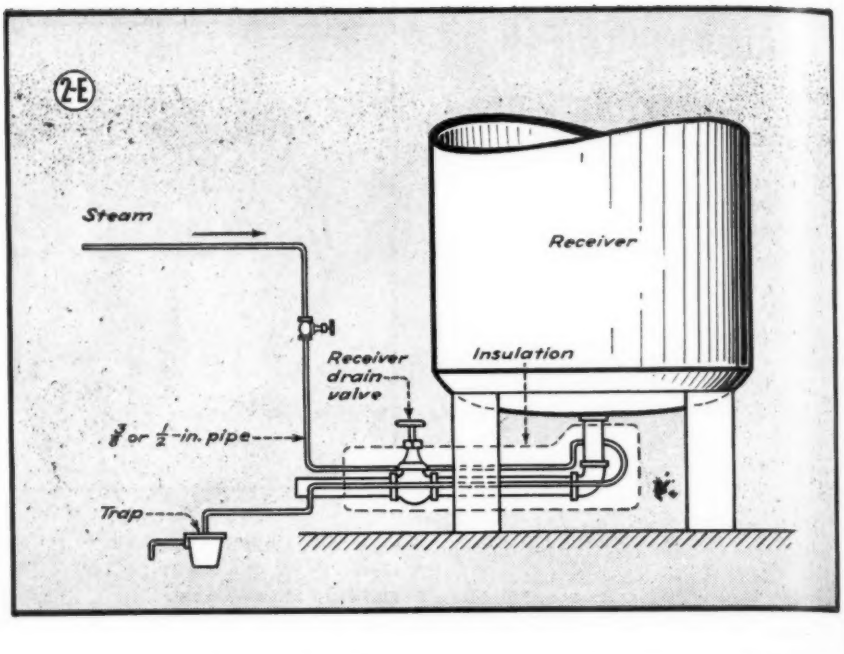
Chicago, Ill. T F RUSSELL

Insulate Drain Line

SIMPLEST WAY to overcome DLW's problem is to insulate drain line from the receiver to the point where it enters the main line or sewer. A distance of 2 ft is sufficient, in average localities, for a pipe to be insulated below the ground level.

Insulation on the bottom and up the tank sides for a distance of 12-in., sketch 2-C, provides ample protection, if water gathers in the tank. Insulation must be applied properly to gain the most beneficial results. The first thing is to apply a covering of heavy tar paper on the dry metal surface, then add three layers of hair-felt with sheets of tar paper between each layer. Finished coat can be a canvas covering sewed around the last wrapping of tar paper. Canvas coat may be painted the desired color with waterproof paint.

Insulate drain line in the same way. However, where it enters the ground protect it so that moisture will not seep in and rot the insulation. If the drain line enters the building to an inside drain, DLW may insulate the outside length up to the building wall.



I don't think it safe to introduce an anti-freeze solution because operators would depend on this medium and when it lost its strength, freezing of the drain line would occur again.

Fairview, N. J. M N GOZDENOVICH

Steam Coil on Drain Line

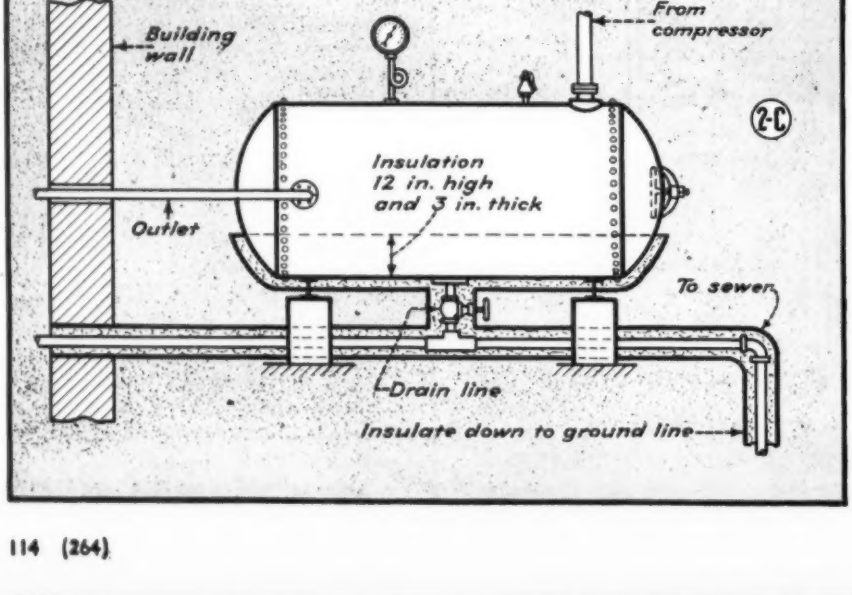
RECENTLY, THE RECEIVER DRAINS froze in a midwestern plant where weather and temperature conditions varied considerably over a 24-hr period. The installation consisted of eight 250-psi air receivers used as compressed-air storage for engine starting and instrument air supply. All receivers were located outdoors behind the power plant.

Regardless of the care and attention plant operators gave to draining, under certain conditions the drain lines could not be kept from freezing. There are times when the drains freeze while the operator is blowing down the receiver. The cooling or refrigerating effect of expanding air is enough to cause a gradual building up of frozen moisture in the drain valve.

We solved the problem quite simply by running a ⅜-in. OD copper tubing around the drain valve and piping at the bottom of the air receiver, sketch 2-E, and connecting the coils to steam supply and exhaust headers. DLW can use one coil or loop made with ⅜- or ½-in. standard pipe fed with low-pressure steam from the heating system. He should provide a shut-off valve near the building and install a trap at the outlet end of the coil. Condensate can be returned to the heating returns or piped to a sewer drain.

In order to make the heating coil effective, steam lines and receiver drain line should be insulated as a unit. Insulation should cover body of drain valve also as this is the point most likely to freeze.

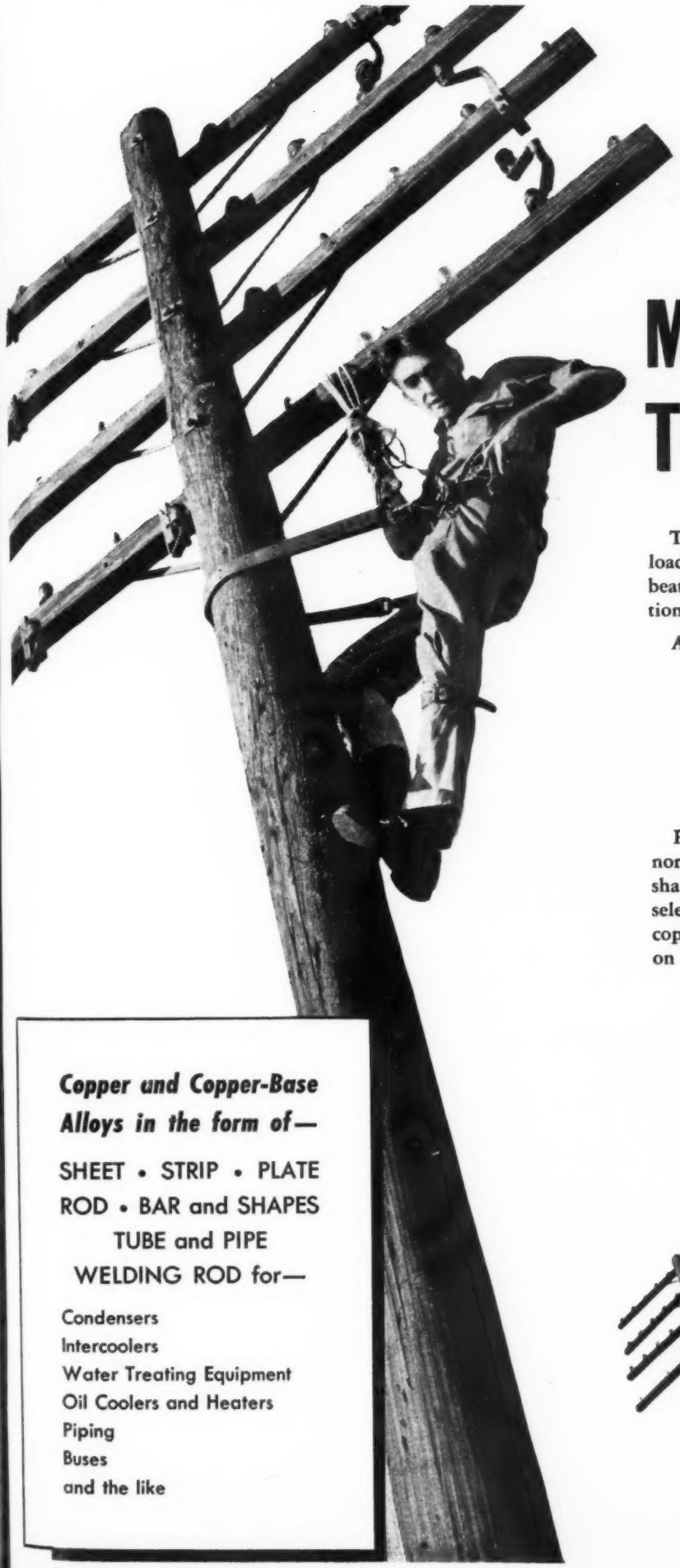
Brooklyn, N. Y. JOHN SALVIANI



Locate Compressor Intake Outside

DLW'S PROBLEM IS BEST SOLVED by checking drain lines. See that no globe valves are used as they form pockets. Pitch line toward inside of building to avoid water pockets. Use ¾-in. pipe for tank drain.

A float trap located inside the building provides a continuous drain. If this is done the line need not be covered,



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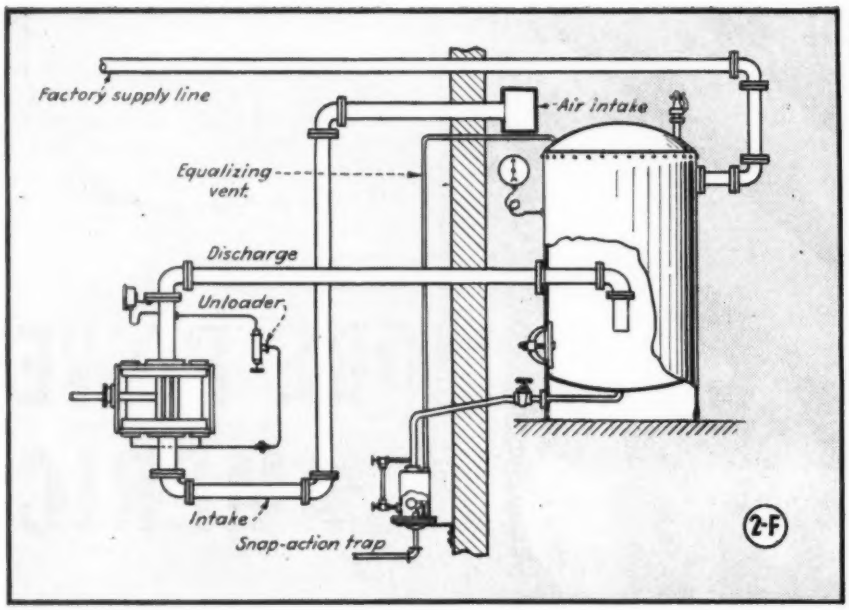


although if the pipe is long and exposed it should be insulated to prevent gradual freezing. If compressor intake is inside the plant, pipe it to the outside because outside air is much drier, which reduces condensation considerably. If receiver is in an unusually cold spot I suggest changing tank inlet from top to center connections, putting an elbow and short nipple on inlet inside the tank, sketch 2-F, to deflect hot air downward and keep bottom of tank warm.

Ottawa, Ont. JOSEPH BONGIORNO

Steam Heating Coil On Receiver

IF AIR FLOW is continuous at 200 cfm, DLW should be able to prevent freezing of drain lines by insulating the receiver and outside piping with 1 in. of 85% magnesia, or similar material, with a weatherproof covering. Allowing the air to discharge from the compressor station at 100 F should provide enough heat at the receiver to prevent freezing of condensed moisture. It may be necessary to restrict air cooling in aftercoolers to maintain air temperature required. This method assumes continuous air flow and condensate removal.

To take care of intermittent flow or reduced flow during any period, install a small manually controlled steam coil, sketch 2-D, or electric heater at the receiver. With air leaving the compressor station at 100 F, moisture precipitation at the receiver is greatly increased. This improves draining.

To completely prevent condensation in the receiver probably involves a refrigerated cooling system with a separator and a chemical absorption chamber. To have moisture content below that corresponding to the dewpoint at temperatures below 32 F requires complete removal. The slightest variation from ideal conditions would result in a recurrence of the present trouble.

Use of antifreeze introduces many complications and makes definite control difficult. Keeping the moisture and container above freezing temperatures at all times offers a definite means of control at low cost. A thermometer in the condensate discharge line is a reliable and simple control indication. In other than freezing weather normal operating procedure could be followed.

Sketch shows the method proposed. Size of the heating coil would depend on receiver size, minimum air-flow rate, and air temperature leaving compressor station that can be continuously maintained. Heater could be added after the effect of insulating the equipment has been determined in the field.

Saint John, N. B. C G CLARK

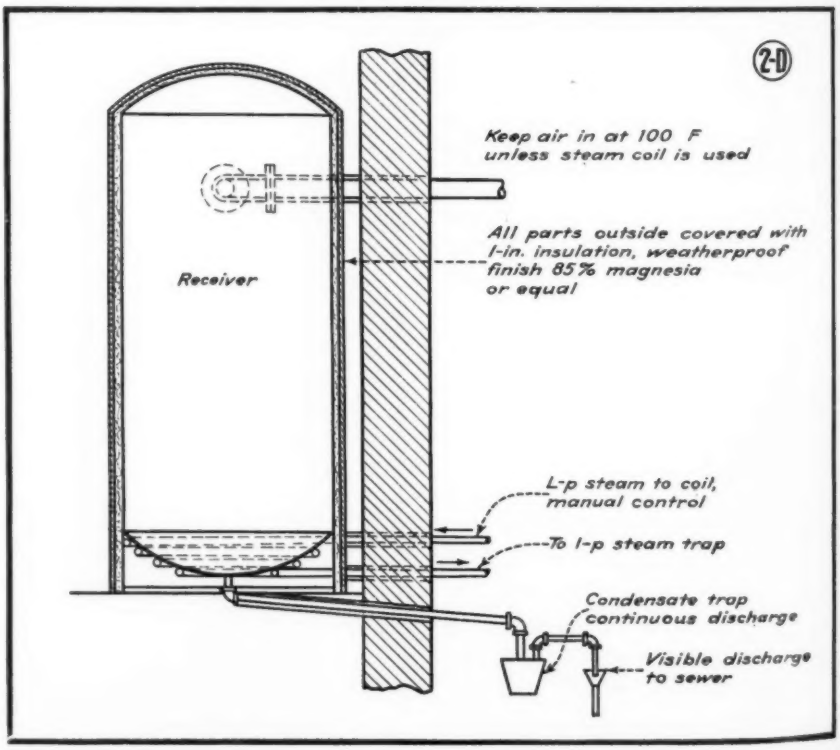
Try Needle Valve Drain

DLW'S PROBLEM IS SIMILAR to one that I faced several times. Simplest solution is to keep the drain valve cracked. However, since this valve is outside, it is rather difficult to keep it cracked and under supervision during extremely stormy days.

I suggest that he install a tee on the discharge line with a small length of pipe and valve. From the center opening of the tee extend a line into the building. (If the tank is on the ground outside extend this line into the basement.) Put a needle valve on the line and locate it so that it will empty into a sewer. Keep needle valve cracked open just enough to bleed the moisture. This keeps the line from freezing as the tank now has a continuous blowdown. Valve can be regulated so that it wastes a minimum of air and yet protects the line.

If the amount of air used throughout

(*Continued on page* 164)


2-D
Keep air in at 100 F unless steam coil is used
All parts outside covered with 1-in. insulation, weatherproof finish 85% magnesia or equal
Receiver
L-p steam to coil, manual control
To l-p steam trap
Condensate trap continuous discharge
Visible discharge to sewer

Yarway Impulse Traps

For Pressures Up to 1500 lbs

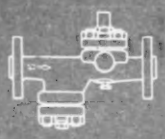


Fig. No. 140 to 147. Medium pressure integral-strainer Impulse Trap for pressures up to 600 lb. Steel body, flanged connections.

Fig. No. 250 to 257. Medium pressure integral-strainer Impulse Trap for pressures up to 600 lb. Steel body, socket weld connections.

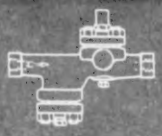


Fig. No. 410 to 417. Low pressure integral-strainer Impulse Trap for pressures up to 150 lb. Bronze body, screwed connections.

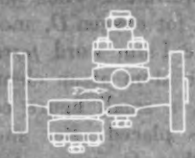
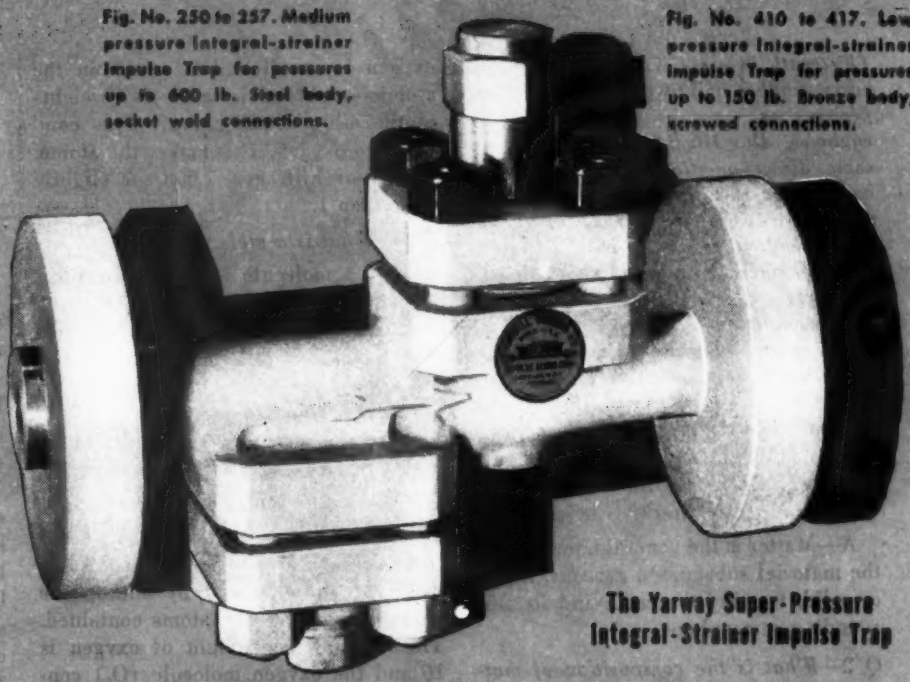
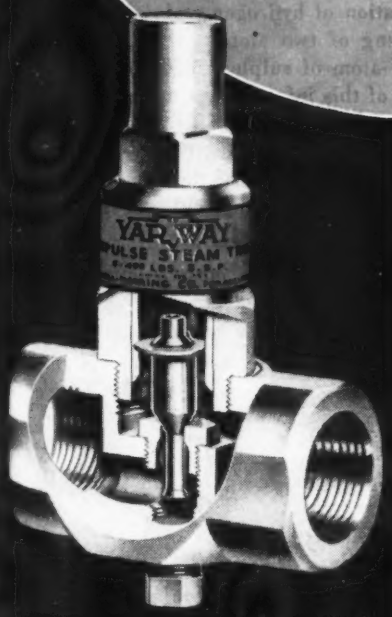


Fig. No. 150 to 157. Super-pressure integral-strainer Impulse Trap for pressures up to 1500 lb. Steel body, flanged connections.



The Yarway Super-Pressure Integral-Strainer Impulse Trap



The Standard Yarway Impulse Trap. Note only one moving part — a little valve.

ALONG with the remarkable success of the YARWAY IMPULSE TRAP for standard trapping service (more than 250,000 have been purchased), has come its use in steam plants where pressures as high as 1500 lbs and temperatures as great as 900°F are encountered.

The integral-strainer trap shown above, developed for this service is suitable for every drainage requirement in high pressure steam installations. It has ample condensate capacity when system is being "warmed up". It will handle relatively small amounts of high temperature condensate, efficiently, without losing its prime.

The valve closes positively in the presence of dry or superheated steam.

It is a fraction of the size and weight of other type traps designed for the same service—saving space, simplifying installation and requiring no support.

It is suitable for all pressures within a wide range without change of valve or seat.

It has the same simplicity of design as does the standard Impulse Trap—only one moving part, a little valve.

Its integral-strainer protects the trap against scale and rust in the system.

For complete description of operating principle, send for Bulletin T-1738.

YARNALL-WARING COMPANY, 100 MERMAID AVE., PHILADELPHIA 18, PA.

YARWAY IMPULSE STEAM TRAP

13—*Some Important Fuel Facts*

Thirteenth in a series that is running in every number of* POWER. *From long experience as a professional and practical engineer, Alex Higgins asks and answers some direct questions regarding power equipment — its construction, principle, maintenance, efficiency and safe operation. In outstanding fashion he drills the young power engineer, polishes up the oldtimer's knowledge, helps all comers pass engineer examinations and win certificates of higher grade. Besides being invaluable as a study course for examinations, it is a good review for the chief himself who wants to do a better job.—Editor.

Q 1—*What is "matter"?*

A—Matter is the general name for all the material substances, gaseous, liquid or solid, forming the earth and its surrounding atmosphere.

Q 2—*What is the composition of matter?*

A—All matter is composed of simple substances called "elements," or combinations of these elements. For example, by combining the two simple substances, iron and carbon, we get steel. Water is a combination of two gases, hydrogen and oxygen. There are 92 elements, ranging from hydrogen, the lightest element, to uranium, the heaviest.

Elements seldom occur in their pure state, but are usually combined with other elements in varying proportions to form the infinite variety of material things in our universe.

Q 3—*What is an atom?*

A—An atom is the smallest particle of matter that can take part in a chemical change. It is composed of yet smaller particles called *electrons* and the number of electrons in the atom determines its weight. Hydrogen, the lightest element, has one electron rotating around a *proton.*

Q 4—*What is meant by atomic weight?*

A—This refers to the *comparative* weight of the atom. For convenience, oxygen is usually taken as 16 on the atomic-weight scale and the weights of the other atoms are given as compared to oxygen. This makes the atomic weight of hydrogen 1.008, or slightly more than 1.

Q 5—*What is a molecule?*

A—A molecule is the smallest particle of matter that can exist alone. It is composed of two or more atoms of the same or different elements. For example, a molecule of oxygen is composed of two atoms of oxygen, and a molecule of carbon dioxide is composed of one atom carbon and two of oxygen.

Q 6—*What is meant by molecular weight?*

A—Molecular weight, or weight of a molecule, is calculated by adding the atomic weights of the atoms contained. Thus, the atomic weight of oxygen is 16 and the oxygen molecule (O_2) contains two atoms, so the molecular weight of oxygen is $16 \times 2 = 32$.

Q 7—*What is a chemical combination?*

A—It is the combination of atoms of two or more different elements to form another substance, very often having entirely different physical properties. For example, two atoms of hydrogen gas combine with one atom of oxygen gas to form one molecule of water.

In a given chemical compound the atoms always combine in the same proportions. Their combining is a chemical change.

Q 8—*What is a mechanical mixture?*

A—A mechanical mixture is a physical mixing together of two substances, and does not entail any chemical change. A mechanical mixture may be again split up into its component parts by some mechanical or physical process, such as screening or washing. For example, we could mix sugar and salt and then separate them by washing out the sugar. This would be a purely mechanical process.

Q 9—*How do you usually denote the composition of a complex substance?*

A—Writing out the names of the elements in full every time they are used would be rather a laborious process, so we use a system of symbols instead. Usually the symbol is the first letter, or letters, of the name, or its Latin equivalent. Thus, for carbon we write *C*, for oxygen *O*, and for iron *Fe*, from the Latin word *ferrum*. If more than one atom of an element is to be denoted, a small figure called a subscript is placed after and below the letter, thus O_2 means two atoms of oxygen, O_3 means three atoms, and so on.

Any combination of elements can be shown very simply and plainly by these symbols and subscripts. For example, hydrogen sulphide is a chemical combination of hydrogen and sulphur, consisting of two atoms of hydrogen and one atom of sulphur in each molecule. All of this information can be conveyed briefly by writing H_2S. If more than one molecule is to be denoted, a large figure is placed in front of the symbol. Thus, $2\,H_2S$ means two molecules of hydrogen sulphide.

Q 10—*Name the most common elements in fuels and give their chemical symbols and atomic weights.*

A—*Element*	*Chemical symbol*	*Atomic weight*
Hydrogen	H	1.008
Carbon	C	12.005
Nitrogen	N	14.01
Oxygen	O	16.00
Sulphur	S	32.06

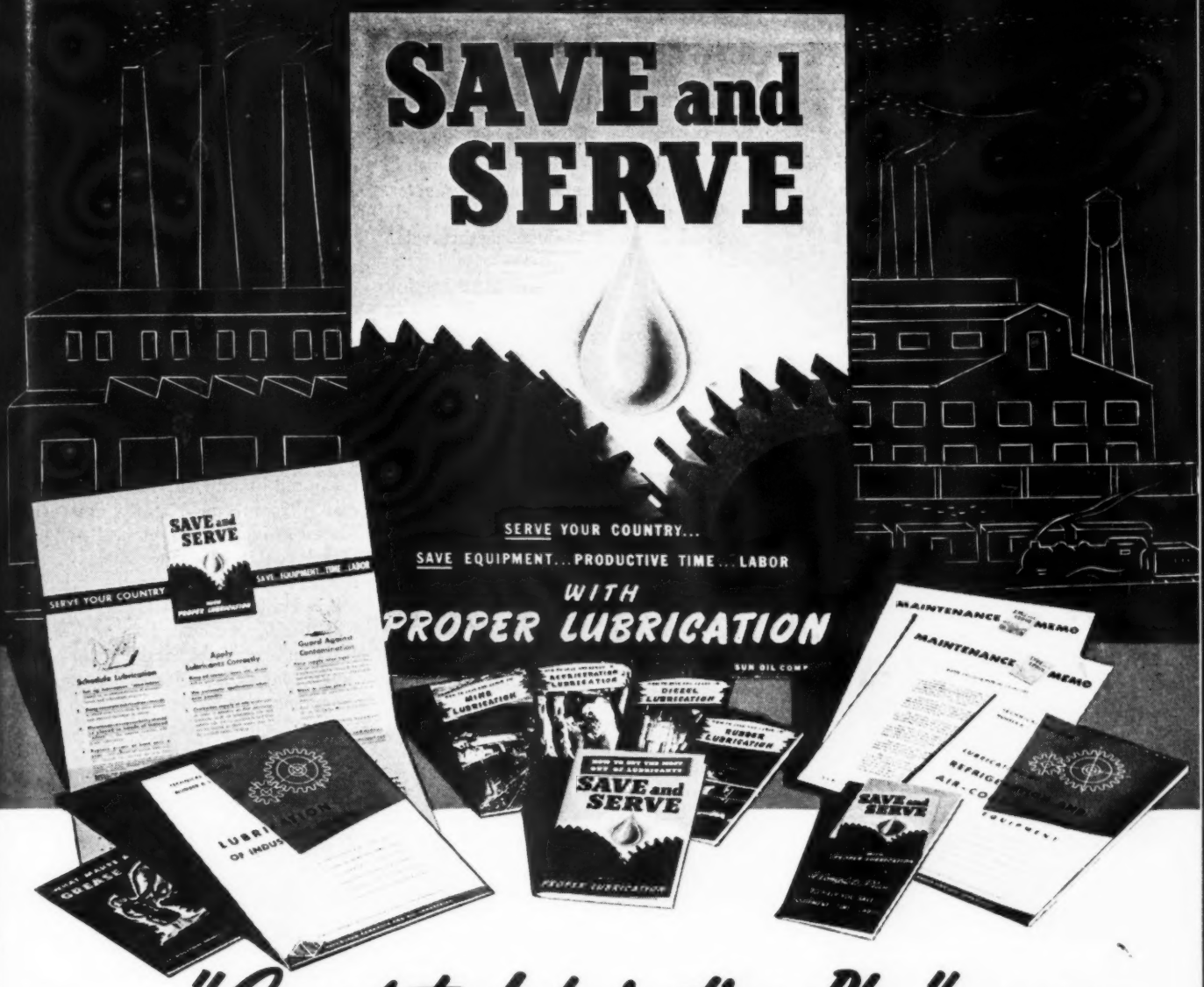
These are the atomic weights, taking oxygen as 16. In calculations where atomic weights are used, the fractions are often neglected, as they are too small to make any practical difference in the answers.

Q 11—*What is combustion?*

A—It is the chemical union of combustible elements in a fuel with oxygen, this union being attended by the production of heat.

(*Continued on page* 120)

SAVE and SERVE



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Q&A FOR POWER ENGINEERS

(*Continued from page* 118)

Q 12—*Where does the oxygen necessary for combustion come from?*

A—From the air.

Q 13—*What is the composition of air?*

A—Air is a mechanical mixture of the gases nitrogen and oxygen, with small percentages of other rarer gases. For all practical purposes we may neglect the rare gases and assume that air consists of nitrogen and oxygen only, in the following proportions:

21% oxygen and 79% nitrogen, by volume

23% oxygen and 77% nitrogen, by weight

Q 14—*What are the principal constituents of the fuels used by the power engineer?*

A—The principal constituents of all fuels used for boiler firing purposes are carbon, hydrogen, oxygen, nitrogen, sulphur, and, for coal, the incombustible elements that form ash.

Q 15—*What is the most accurate method of finding the heating value of a fuel?*

A—The heating value of a fuel can be found most accurately by burning a measured sample with pure oxygen in an apparatus called a *calorimeter*, where the heat of combustion is absorbed in water and the heating value arrived at by noting the rise in the temperature of the water. The heating value of a solid or liquid fuel is usually given as so many Btu per pound, and the heating value of a gaseous fuel as so many Btu per cubic foot, measured at some standard temperature and pressure.

Q 16—*What is a Btu?*

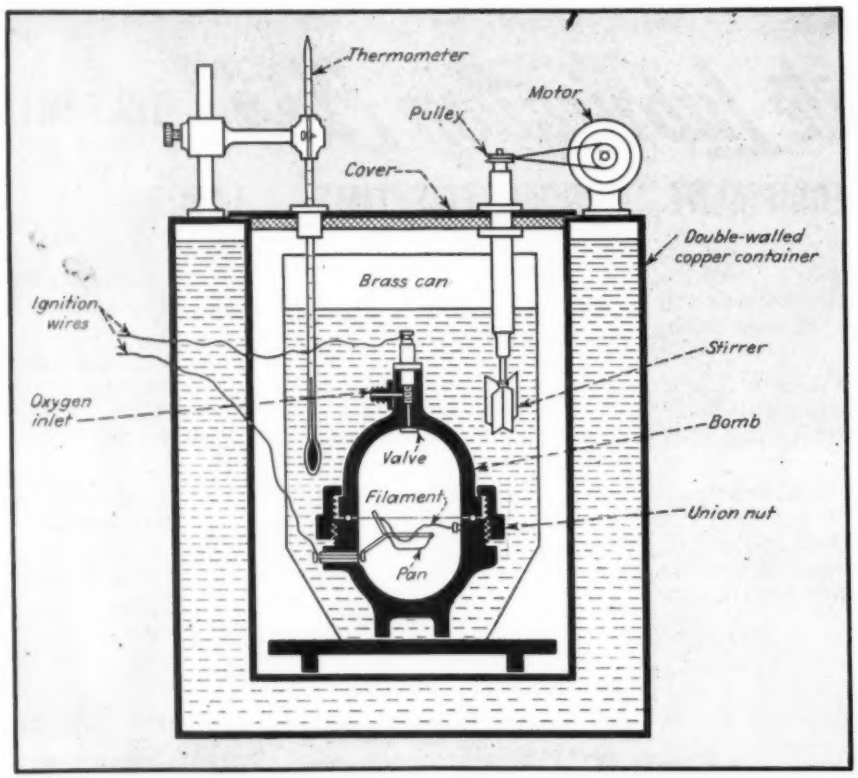
A—Btu is the abbreviation for *British thermal unit*. It is the amount of heat required to raise the temperature of one pound of water from 62 to 63 F. At other temperatures the amount of heat required to raise the temperature of one pound of water one degree may be slightly more or less, but the variation is so small that we usually take 1 Btu as the heat required to raise the temperature of one pound of water through one degree at any temperature.

Q 17—*Describe a calorimeter for finding the heat values of solid fuels.*

A—One common form of calorimeter is shown in the sketch. It consists of a hollow steel cup or *bomb* made in two parts that can be fastened together by a large threaded nut in much the same way as a pipe union. A lead gasket between the faces insures a tight joint. The walls of the bomb are thick to withstand considerable internal pressure when the fuel sample is burned. It contains a pan for the sample of fuel and means for electrically igniting it. A valve is also provided through which oxygen can be forced into the bomb.

To make a test, a carefully weighed sample of fuel is placed in the pan, the halves of the bomb are screwed tightly together, the bomb is filled with oxygen under high pressure and then placed in a brass can containing an accurately measured quantity of water at approximately room temperature. This can is placed inside of a double-walled copper vessel containing water, also at room temperature. Sometimes the outer vessel is built like a large vacuum bottle with the air exhausted from the space between the double walls to provide a better insulating jacket around the inner can. A thermometer in the inner can registers the rise in water temperature, and a small motor-driven paddle wheel stirs the water so that the heat is evenly diffused throughout its entire mass.

At the start of the test, the current is switched on, the glowing wire in the bomb ignites the fuel and the heat given off by its combustion passes through the walls of the bomb to the water. Rise in temperature of the water is measured by the thermometer. From this reading, together with the weight of the fuel sample burned, and the weight of water heated, it is easy to compute the heat value in Btu per pound.



Heat value of coal is measured by burning weighed sample with oxygen gas in a bomb calorimeter and noting temperature rise of water

Q 18—*What are the principal substances used as fuels by the engineer?*

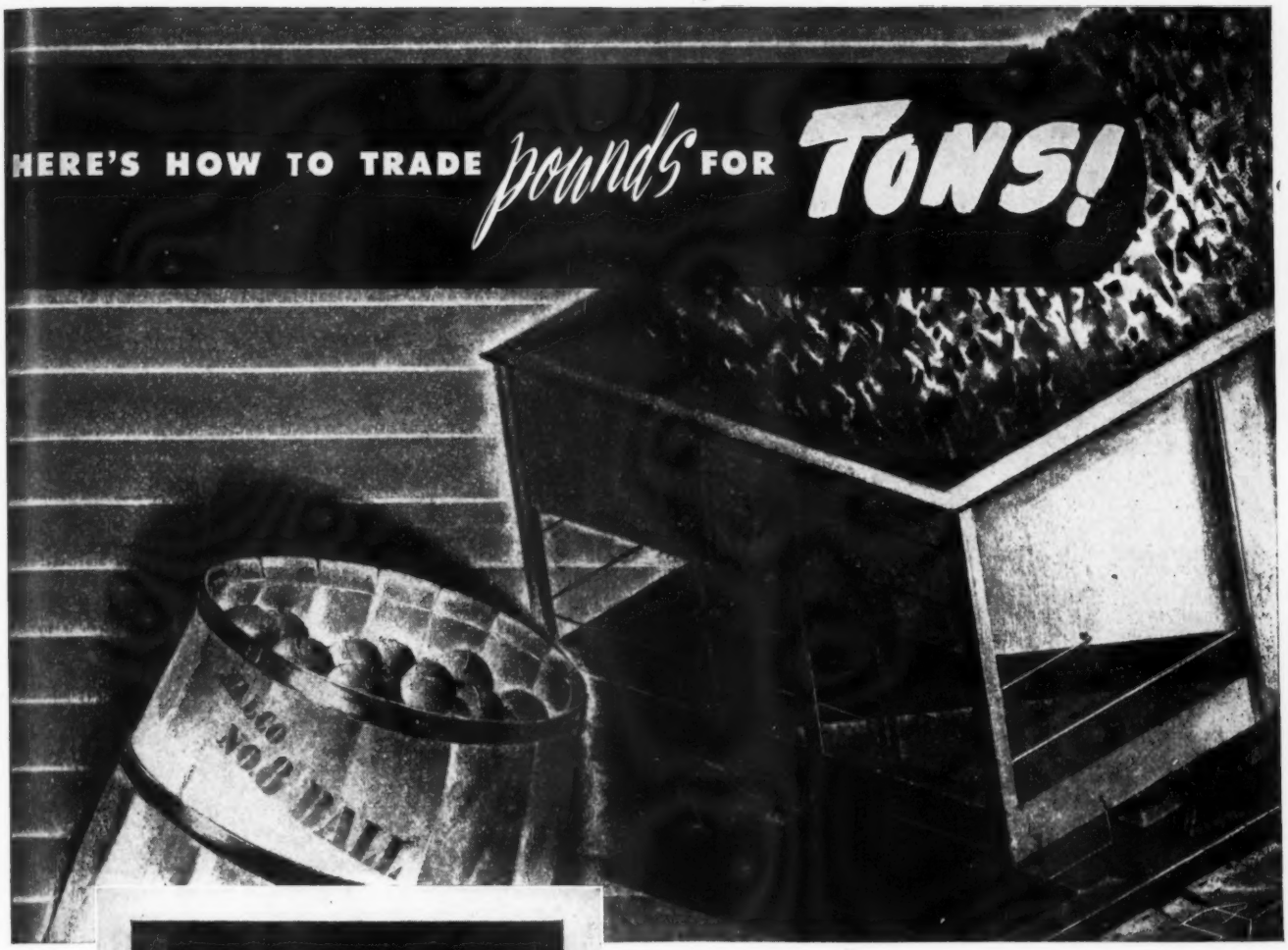
A—The principal ones are solids, such as wood and coal; liquids, such as fuel oils derived from petroleum; and gases, such as natural gas, producer gas, blast-furnace gas and coal gas.

Q 19—*Into what classes is coal divided?*

A—Numerous methods of classifying coal have been used and suggested, based variously on carbon content, ratio between fixed carbon and volatile matter, also on the coking or non-coking qualities and other physical characteristics. Nevertheless, the great differences in the composition and physical appearance of coals from the various coal fields, and even from different sections of the same coal seam, make it hard to find any entirely suitable and satisfac-

(*Continued on page* 140)

HERE'S HOW TO TRADE *pounds* FOR TONS!



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AUTHORITATIVE sources have reported that 1/9 inch scale on boiler tubes can cause heat losses as high as 16%. That means a heavy waste of coal and loss of boiler capacity.

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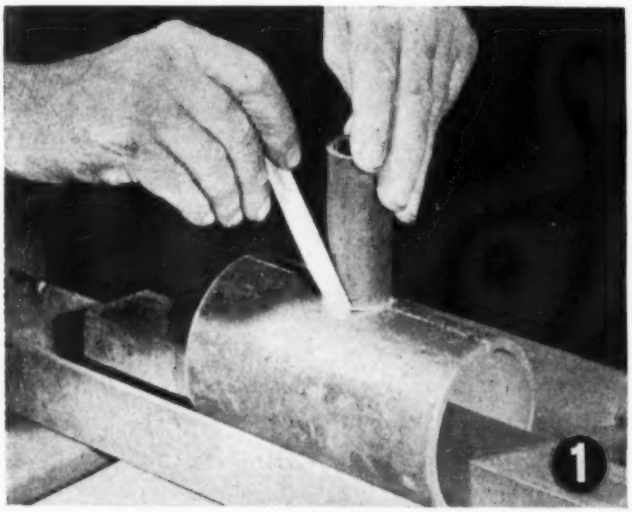
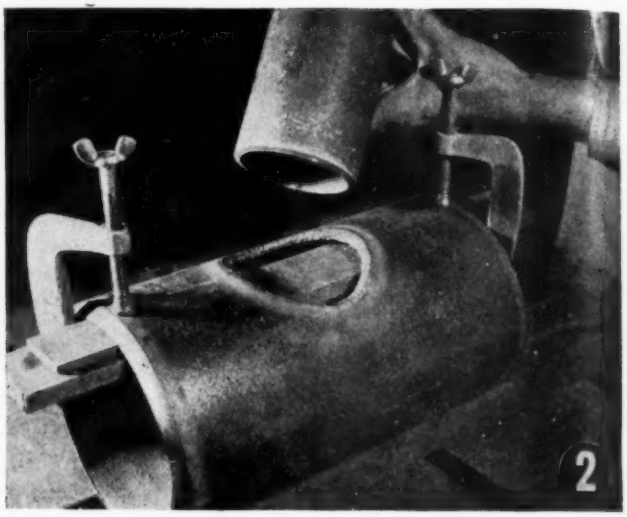
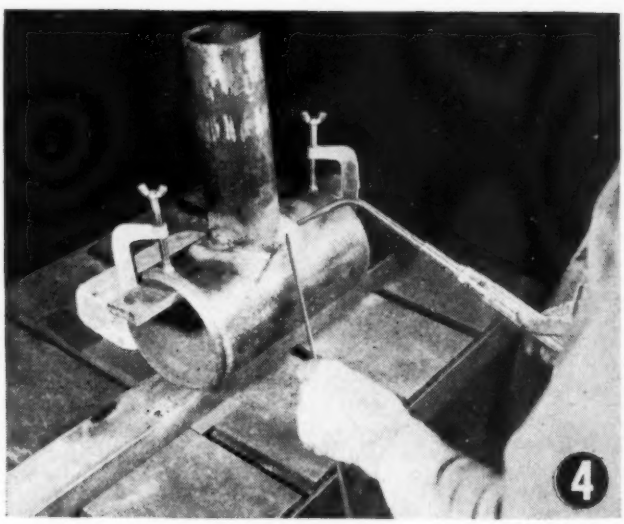
HOW TO FABRICATE IRON PIPE FITTINGS

WELDING a relatively small-diameter branch line into a larger-diameter header frequently causes some difficulty because of the difference in wall thickness. Here is a step-by-step procedure that enables the welding operator to perform this operation easily and quickly. Although the photographs illustrate fitting fabrication in the shop, the method is easily adapted for field use when joints are fabricated during erection. *Courtesy, The Linde Air Products Co*







1 Place the nipple in position and with a piece of sharpened soapstone, mark off the hole on header. Then make center-punch marks about ¼ in. apart around the soapstone circle. Heat from the torch quickly destroys soapstone but the center-punch marks remain visible

2 Cut out the circle by holding cutting torch nozzle perpendicular to the pipe all around the circle. Strive to get a good round hole, just large enough to admit nipple after all oxide is knocked off the cut edge. Bevel the edges to a 45 deg angle leaving a shoulder at bottom edge of cut about one third the pipe wall thickness

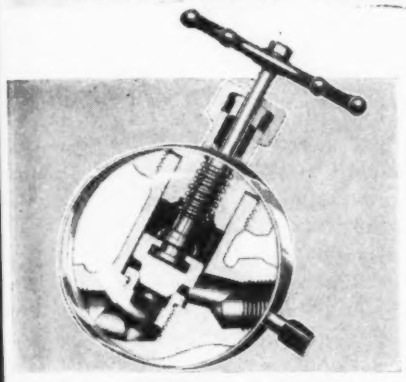
3 End of nipple must be trimmed; otherwise, it would have a poor fit at the sides or extend too far inside the header. To mark off the nipple end, insert it in the hole to rest against a bar clamped below inner surface of header. Edge of nipple should come just flush with lower edge of bevel at side of hole. Mark end of nipple with soapstone following along contour of the header. Make permanent marks with center punch and remove the end with a cutting torch. Cut the edges square; beveling the nipple edges is not necessary

4 Draw up the bar until it rests snugly against inside surface of header and put the nipple in position for welding. Tack weld it on one side and then straighten it into exact alignment by tapping with a hammer before making the second tack

How to buy a *Forged Steel Stop* VALVE...

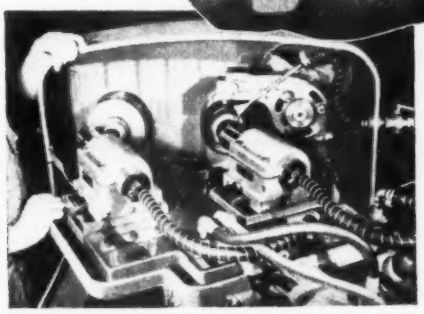
THERE'S more to buying a forged steel stop valve than a figure number, a price and a purchase order if you're interested in fitness for tough service and the real economy of long life and low maintenance. It's the important details of design, construction and processing of each material and part that makes the difference in forged steel stop valves.

Here's what to look for!



1 THE "WEAR ZONE"

Here's where a valve takes the most punishment. Edward builds extra life and extra protection against corrosion and erosion into this "wear zone" through EValloy stainless steel or Stellite seats and disks. Threads of both the seat and body are of the finest Class 4 commercial fit.

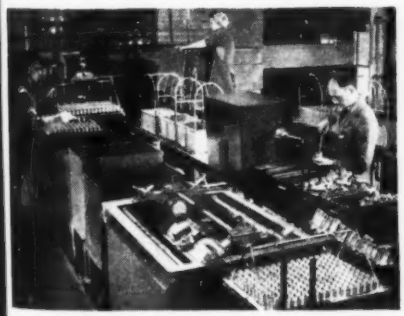


2 DROP TIGHT FIT

Seats and disks for Edward forged steel stop valves are precision borized in pairs on special machines (above). Mated seats and disks, absolutely concentric and smooth, show practically 100 per cent bearing surface when tested with blued gages. The result—drop tight valve closure.

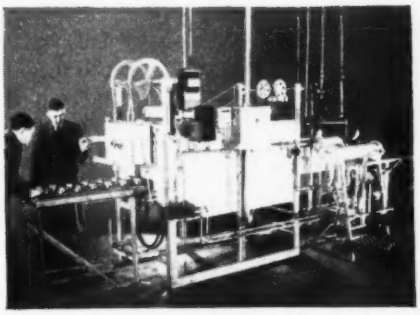
3 EASY OPERATION

Handwheels are mighty important. Handwheels for Edward forged steel stop valves are strong malleable iron, knobbed and easy to grip even with wet hands. Oversize dimensions facilitate operation. No other manufacturer puts larger handwheels on steel valves of like size.



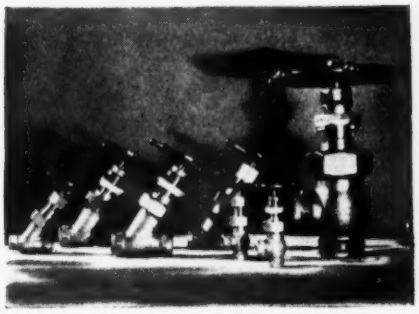
4 EVALIZED SURFACES

EValizing, the new exclusively Edward plating process, adds years of service to stem bearing surfaces, protects other exposed surfaces such as packing nuts, bonnets, junk rings, etc., against rust, corrosion and abrasion. Above, a section of the Edward plating department.



5 PROPER PROCESSING

Bodies, bonnets, seats, disks—all principal parts of Edward steel stop valves go right from the drop forge hammers to special furnaces, like the one above, for heat treatment under the control of Edward metallurgists for protection against indeterminate stress in service.



6 WIDE ADAPTABILITY

Globe or angle, inside screw or O. S. & Y., sizes ¼ in. to 2 in., screwed ends or ideally proportioned socket welding ends. But in every size and type, they're all steel, equal to any stress or strain. For illustrations, dimensions and concise data on the Edward line, write for Cat. No. 101.

THE EDWARD VALVE & MFG. CO., INC. • EAST CHICAGO, INDIANA

EDWARD *Steel* VALVES

ARGUMENT CORNER

More on the Blowdown Tank

REFERRING TO FCT's QUESTION in Dec. 1943, on the method of connecting a blowdown tank, his sketch is approximately correct provided the proper pipe sizes are used for inlet, discharge and vent lines. A blowdown tank should be designed and installed to perform three functions:

(1) To absorb the impact of water being blown from the boiler. (2) To provide a place for liberation of steam which forms when the pressure is reduced at end of blowoff pipe. (3) To provide a storage space for the blowdown so that it can be cooled before it is blown into the sewer, or other discharge point.

If the vent and discharge pipe are of proper size, pressure in the tank should not exceed 10 to 15 psi; however, the tank should be built for at least one-half boiler pressure and constructed in accordance with the ASME unfired pressure-vessel code (or constructed in accordance with State or local laws). It should be of sufficient size to hold approximately one gage of water from the boiler.

Vent pipe on the blowdown tank should have a cross-sectional area at least four times that of the inlet pipe (unless State or local laws require a larger size vent), and no stop valve should be installed in the vent pipe. It should extend up at least 15 or 20 ft, and end at a safe discharge point.

Blowoff pipe from the boiler should enter the side of tank near the top and discharge line should be at about the same height. Discharge pipe should have a cross-sectional area of approximately twice the area of inlet pipe, with an internal pipe extending down within a few inches of the tank bottom.

As the tank normally stands partly filled with water, it should have a hand-operated drain, so that the tank can be emptied for cleaning or repairs. Locate the tank so that external surfaces are protected against corrosion and are accessible for inspection.

Chicago, Ill. A E STEVENSON

Put Hard Packing Next to Gland

I READ WITH MUCH INTEREST the article on centrifugal pump packing, by Hugh Platt in Jan, 1944, POWER. However, I disagree with one statement and believe the drawing, Fig. 4, in Jan is incorrect. The statement is made that denser packing is placed in the bottom of the box, and softer packing near the gland. It is a well-known fact that all the rings of packing in a stuffing box do not receive the same compression.

Under ordinary conditions, the rings nearest the gland would be compressed most. One of the reasons for using two densities of packing is that the denser packing may be placed next to the gland as corrected, in Fig. 2, so that more thrust can be transmitted to the bottom rings than would be possible if soft packing were used throughout. I believe you will find that this is the primary reason for using the multiple packing rings rather than any effect the arrangement might have in preventing the internal pump pressure from getting behind the packing and compressing it too much.

I have observed that internal pressure causes undue compression if the stuffing box is not completely filled, no matter what the packing arrangement in the box. It is, of course, common practice to use one hard ring at the bottom of the box to prevent the extrusion into the casing of the softer packing behind it.

New York, N. Y. JOHN E LANCASTER

[Mr Lancaster is correct. The editor regrets very much that his misunderstanding of the original drawing caused the error to which attention is called.]

Feedwater Regulator Connections

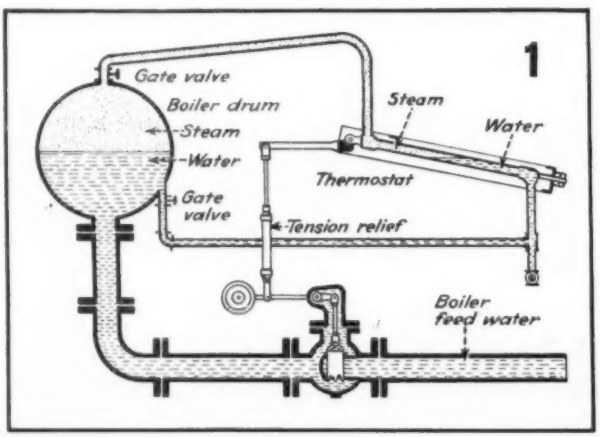
WITH REFERENCE TO Higgins "Questions and Answers," Dec, POWER, here are a few comments on the feedwater regulator drawing, Fig. 3, page 118: Used primarily to illustrate the operating principle of the thermo-mechanical feedwater regulator, it serves the purpose very well. However, since the thermostat connections to the boiler drum were shown in detail, we call attention to several departures from recommended practice to assure correct operation of the regulator.

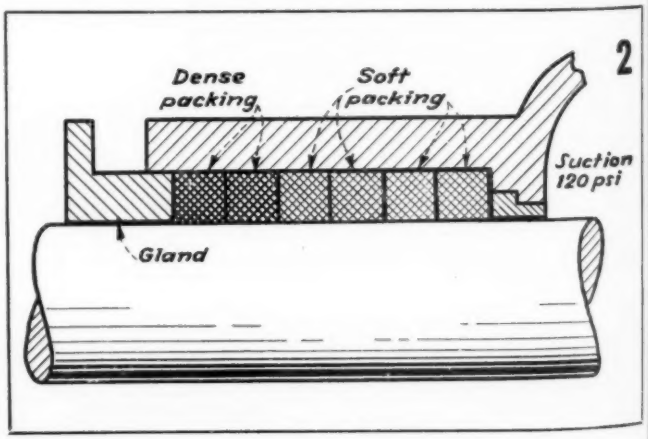
(1) The valve in the thermostat steam connection should be a gate—not a globe. (2) Pipe bends should be used for changes in direction—not pipe fittings. (3) The steam connection should slope toward the drum. (4) The water connection at the drum should not be so close to the feedwater inlet.

Correct representation is shown by the diagram, Fig. 1, below.

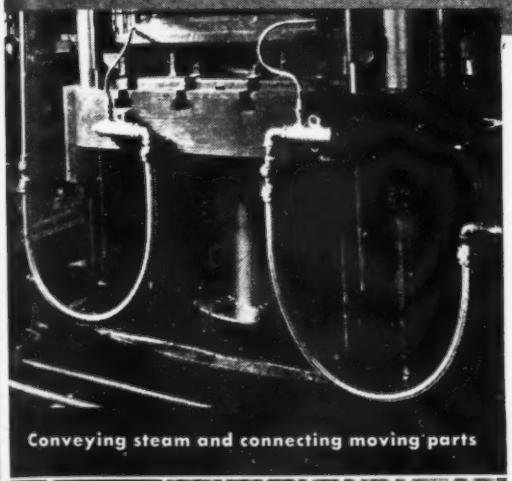
Function of the first three suggestions is to avoid the possibility of condensa-

(*Continued on page* 166)





SEAMLESS METAL TUBING
...flexible as a blacksnake whip



Conveying steam and connecting moving parts

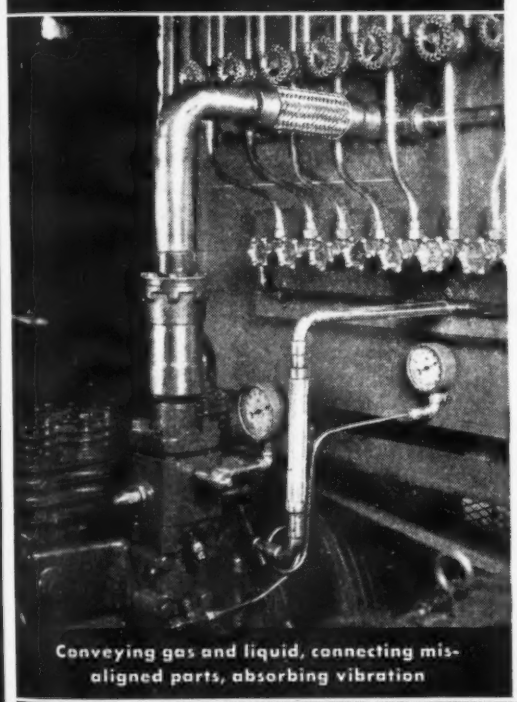
meets a thousand exacting requirements

The tubing is American Seamless Flexible Metal Tubing—the most reliable type of flexible metal conveyor obtainable where *absolute tightness is essential.* Because it is jointless it is, in effect, a flexible pipe.

Applications are practical in literally thousands of places in industry. Typical functions are illustrated on this page:

1. *For conveying steam.*
2. *For conveying liquids and gases.*
3. *For absorbing vibration.*
4. *For connecting misaligned or moving parts.*
5. *For protecting electrical wiring.*

Our technical department is experienced in designing flexible metal assemblies for specific applications. If you have a particular problem, maybe we can be of assistance to you. 44192



Conveying gas and liquid, connecting misaligned parts, absorbing vibration

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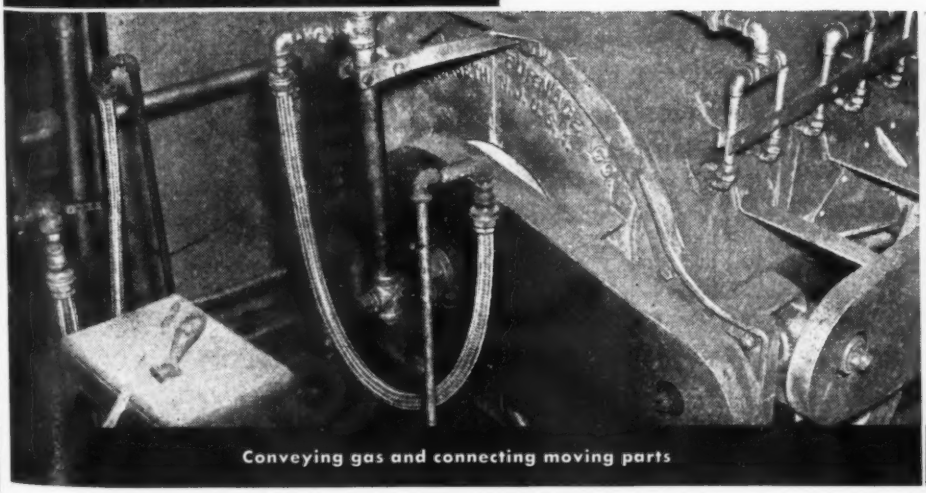


Conveying gas and connecting moving parts

Use in product design and protection of electrical conduit

WHAT'S NEW IN PLANT EQUIPMENT

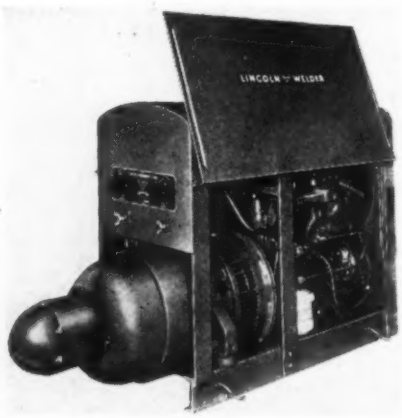
Expansible-Tube Valve

VALVE OF UNUSUAL CONSTRUCTION for cold-fluid service, salt water, chemical solutions, oil, gas and air. Operates by manual or automatic remote control through hydraulic unbalanced pressure on cylindrical flexible tube stretched tightly over slotted core. Fluid pressure in the line forces tube to expand against inner wall surface of valve body for streamline flow. Diverting line pressure into actuating chamber flexes tube

closed over core. Bubble-tight air-tight shutoff maintained indefinitely without sticking. Control feature eliminates chains or motorized equipment. May be adapted to solenoid, mechanical or automatic control. Sizes 1½ to 24 in. *Grove Regulator Co, 6547 Green St, Oakland 8, Calif.*

Arc Welder

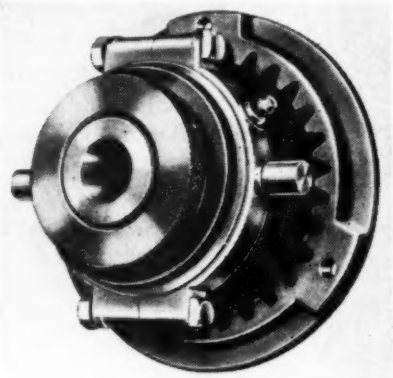
SHIELD-ARC ENGINE-DRIVEN WELDER, rated at 200 amp, is of lightweight, rugged construction with inclosed, rubber-mounted engine of 29 hp. Unit, supplied complete with base and canopy,



has a current range of 40 to 250 amp. Dual control of welding current is by adjustment of series fields and generator speed. For metallic arc welding, with bare or coated electrodes, model also supplies uniform welding current for carbon-arc welding. Generator control is said to assure accuracy of open-circuit voltage and permit precise control of engine speed from 1500 to 1150 rpm. Control may manually reduce engine speed to as low as 750 rpm when necessary to stop welding for a few-minute interval. *Lincoln Electric Co, Cleveland, Ohio.*

Friction Clutch

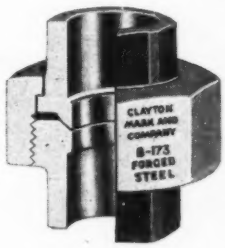
ROLLING-GRIP FRICTION CLUTCH is an easy-to-operate disk clutch for small power requirements. Instead of toggles, a number of highly polished hardened-steel balls are forced into a V-shaped groove by a hardened-steel cam. Forcing balls toward shaft center widens V-



shaped groove. This application of basic principle of inclined plane or wedge produces a heavy power-transmitting pressure on friction surface. There are no links, pins, cotters or other highly stressed mechanical parts to break or wear out. Clutch adjustment is controlled by a threaded collar locked in place by two setscrews. Adjustment is simple: With clutch engaged, loosen the two setscrews and tighten adjusting nut by hand. Then disengage clutch and tighten adjusting nut by a small fraction of a turn. Setscrews are then tightened to lock the adjustment. Clutch may be adapted to any operating condition. It will be made with a 3½-in. dia disk, rated at ½ hp at 100 rpm, or with a 4½-in. dia disk, rated at 1 hp at 100 rpm. *Dodge Mfg Corp, Mishawaka, Ind.*

Welding Union

UNION, SOCKET-WELD, in sizes from ⅛ to 3 in., with ends reamed to U. S. Navy specification B-173, unless otherwise specified. Corresponds to A A R specifications insofar as over-all dimensions,

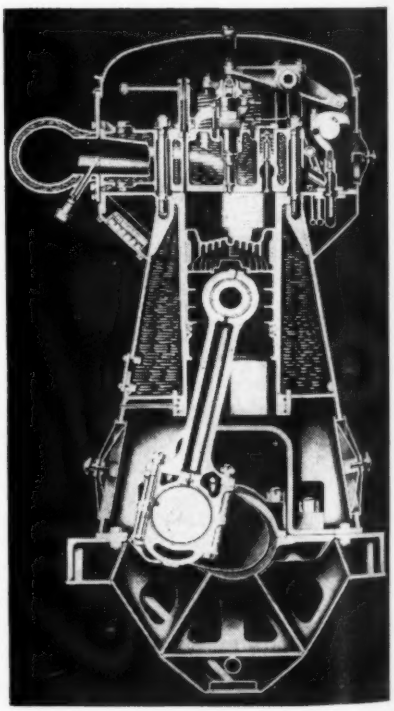


seats and nut threads are concerned. Heavy-duty construction. Meets need for removal of apparatus, valves, traps, etc, from welded piping systems for periodical repair. *Clayton Mark & Co, Evanston, Ill.*

Diesel Engines

SERIES 50 DIESELS are 4-cycle 12x15-in. 500-rpm units rated 83.3 hp per cylinder. Use of unit injectors and overhead camshaft simplifies valve gear and permits higher injection pressure for better atomization. Dual alloy-steel intake and exhaust valves operate in removable

(*Continued on page* 184)



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Your own pile of old Leather Belting is probably made up of belts that are still good but which were removed from their jobs because of changes in machines or drives . . . double belts with only one ply worn . . . belts with only a few bad spots . . . and short pieces. All of these can be put back to work by rebuilding . . . by cutting into narrower widths . . . cutting out bad spots . . . and splicing short pieces into a continuous belt.

Call in your belt supplier and ask him to look over your old belting for possible salvage and rebuilding.

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This authoritative booklet contains a lot of factual information on "How To Get The Most From Your Leather Belting." You will find horsepower rating tables . . . instructions for shortening a leather belt . . . how to make belts endless on the job . . . tips on installation and maintenance. A free copy may be obtained from your Leather Belting Supplier or directly from us.

Write for Your Copy!

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Pessimist vs Optimist . . .

Somebody who knew how to turn a phrase once claimed that an optimist says, "The bottle is half full," while the pessimist says, "The bottle is half empty." It's a little, but important, difference in point of view.

I'm reminded of that comparison every time I hear somebody moaning about the big war plants we've built up, and how we're going to face our greatest depression when the war ends. There *is* cause for concern—we can't imitate the grasshopper and let tomorrow take care of itself—but the chances are at least fifty-fifty that we'll enter a great period of prosperity after the war.

All we have to go on is experience after the last war. Then, too, calamity howlers predicted disaster that didn't come. We built tremendous power capacity—and promptly had to build more. Our power use in 1939 was several times what it was in 1921. Our power use after the war will probably go up the same way, based on backlogged demand for appliances and all the new electronic equipment.

A recent copy of "Dividends"* discusses the problem from the angle of chemical plants—of which we are again supposed to have too many. At the end of the last war, we had enough phenol manufactured to last for three years. Price tobogganed from 45c to 6c a gallon and the synthetic plants closed. But in a year or two, all the plants were open again. and we were building new ones.

Sulphur's greatest market at the turn of the century was in the manufacture of chlorine for bleaching textiles. The Castner process killed that market, but along came viscose rayon—which required far more sulphur than chlorine manufacture ever had. That was only one of a series of ups and downs. During the last war, civilian use of sulphur was restricted and stock piles were ordered. When the war ended, we had 1,300,000 tons piled up—almost a three-year supply. But in a few years, consumption had been pushed to *twice that a year*.

Benzol automatically is produced at a rate of four gallons per gallon of toluol from coal. Three months after Pearl Harbor, we were still putting benzol in gasoline to get rid of it. But now benzol is a critical material—vital in synthetic rubber, aviation gasoline, styrene for plastics, etc—so critical that one rubber plant had to use alcohol instead.

This doesn't mean, of course, that there won't be postwar headaches. We'll have plenty. But the best way to cure them will be to find new uses for products rather than to scrap the plants. The answer is research, in which the chemical industry has led. So when the pessimist says, "We've got too much capacity," we optimists can say, "We've got more skilled men to operate it, more ways to use it, and a world market for it."

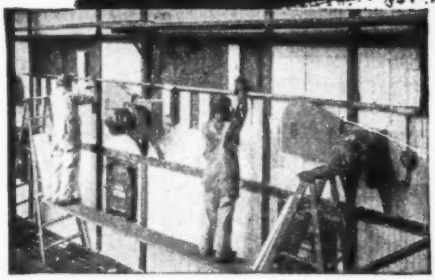
George Edwards
Engineer

*Published by Ketchum, MacLeod & Grove, Inc

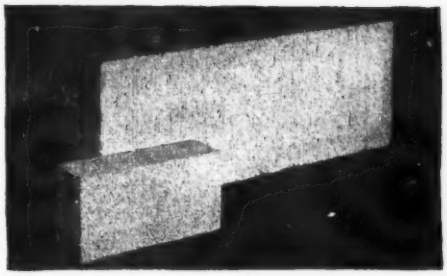
Solutions

TO YOUR TOUGH INSULATING PROBLEMS!

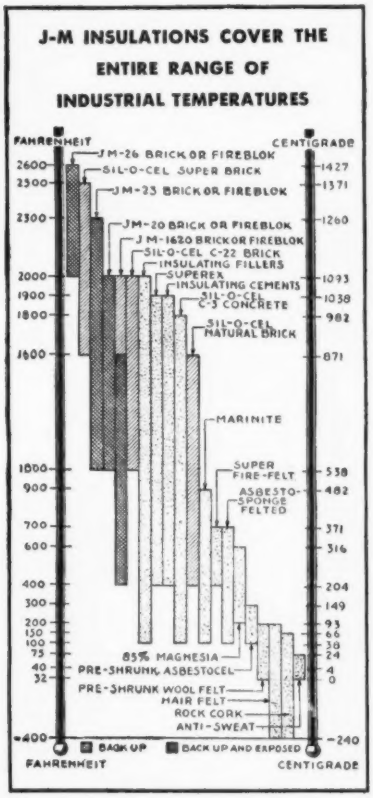
WHATEVER your insulating problem, there's a Johns-Manville insulation that can solve it efficiently and at minimum cost. For, over the past 86 years, J-M's extensive laboratories have pioneered in the field of industrial insulation. Today J-M offers a wide line of insulating materials, each designed for some specific insulation need, for temperatures up to 2600°. For example:

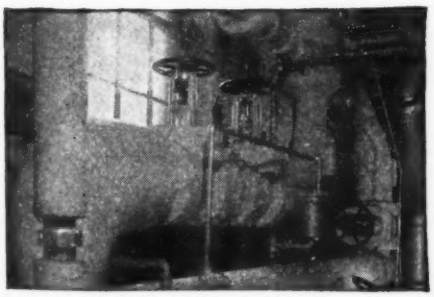


For temperatures to 600° F. J-M 85% Magnesia has been for many years the most widely used block and pipe insulation for temperatures to 600° F. and, in combination with Superex, for higher temperatures. Maintains high insulating efficiency. Standard block sizes 3″ x 18″, 6″ x 36″ and 12″ x 36″; from 1″ to 4″ thick.

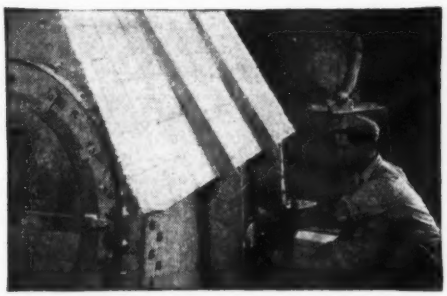


Furnace insulation up to 2600° F. J-M Insulating Brick and Insulating Fire Brick are available in 7 types, temperature limits from 1600° F. to 2600° F. All provide light weight, low conductivity. New Insulating Fireblok, now ready in all four Fire Brick types, are 5 times larger for speedier, more economical installation.





For steam lines up to 700° F. Use J-M Asbesto-Sponge Felted Pipe Insulation for efficiency, high salvage and resistance to abuse. For temperatures over 700° F. use with Superex. In 3-ft. lengths 1″ to 3″ thick.



Insulation for temperatures to 1900° F. J-M Superex Blocks have long been standard for this service. High heat resistance, low thermal conductivity. Sizes 3″ x 18″, 6″ x 36″ and 12″ x 36″; from 1″ to 4″ thick.

For more details on these materials, and on the complete J-M Insulation line, write for Catalog GI-6A. Address: Johns-Manville, 22 East 40th Street, New York 16, New York.

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Johns-Manville INDUSTRIAL INSULATIONS

FOR EVERY TEMPERATURE . . FOR EVERY SERVICE

POWER LINES

Personal notes, items of general interest, the latest from Washington — all the news that is news in the power field

Midwest Power Conference Program

Illinois Institute of Technology has announced the preliminary program for this year's conference, with "Power Brings Victory" as its theme. Both war and postwar problems will be emphasized.

General topics on which discussion sessions will be conducted, **April 13 and 14,** are given in detail below. Eighteen speeches by nationally known

Alex D Bailey

power authorities are included. The meeting will be in Chicago, as usual.

Alex D Bailey, asst to the vice-president of Commonwealth Edison Co, Chicago, will give the keynote address, "Postwar Planning of the Nation's Power Supply." Mr Bailey has been with Commonwealth Edison since 1903. He served as chief operating engineer from 1936 until receiving his appointment to his present position in 1943.

The address of J A Krug, director, office of war utilities, WPB Washington, D. C., will be the feature of the "All-Engineers" Dinner. Widely recognized as a power engineer, Mr Krug has been in Government service since 1936.

Here are some discussion highlights: **Central Station Practice** R K Behr, chairman—sponsored by power and fuels div, Chicago section, ASME. (a) Progress Towards Standardization of Turbogenerators for Central Station Service. M S Oldacre, equipment and research engineer, Commonwealth Edison Co, Chicago. (b) Causes and Pre-

(*Continued on page* 172)

A new diesel engine is now in production at the Sunnyvale, Calif. plant of the Joshua Hendy Iron Works, according to Charles E Moore, president. The new engine, known as Series 50, operates on the 4-stroke cycle and, at 500 rpm, carries the conservative rating of 83.3 hp per 12x15-in. cylinder. Engine design features welded-steel construction, overhead camshaft, dual intake and exhaust valves, oil-cooled pistons, precision bearings, fully automatic lubrication and unit injectors. For additional data, see page 126. The series now in production will be followed by other models leading to a full line of Hendy diesel engines.

✪ ✪ ✪

Grand Coulee Dam's tenth generator went into operation, as a climax to what officials of the U. S. Bureau of Reclamation described as "the greatest expansion of power-generating facilities ever made in a single plant in a year's time." Installed capacity of the plant, situated on the Columbia River in the state of Washington, now exceeds 800,000 kw—third largest in the world and second largest in the U. S. Output is nearly all consumed by Pacific Northwest war industries. Addition of the 108,000-kw generator brought the number of kw installed at Grand Coulee Dam since Feb, 1943, to about 475,000.

✪ ✪ ✪

The 17th National Oil and Gas Power Conference will be held at the Mayo Hotel, Tulsa, Okla., **May 8-10.** The expected 300 diesel engineers attending will take part in an exceptionally important program, featuring papers on gas turbines, turbocharging, gas-diesel engines, exhaust systems, operation and maintenance, governing and engine control. Program details will appear in May POWER.

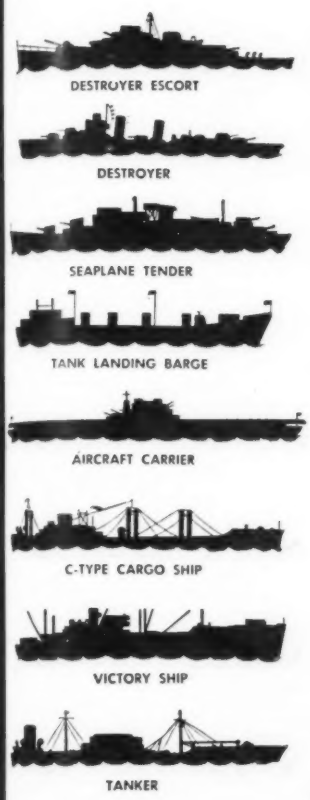
NEWEST CONTROLS FOR DEEPSEA CRAFT

Chief Electrician's Mate Frank R Ferguson, who has served in the Navy for 17 years, watches Electrican's Mate William Vukovcan try out a newly built set of submarine motor controls. These two, and other battle-tested veterans of the Navy's submarine service, are students in a production-line "schoolroom" that teaches submarine men to operate and maintain newly designed electrical equipment Westinghouse is building for the nation's fleet

POWER PIPING DIVISION

equips

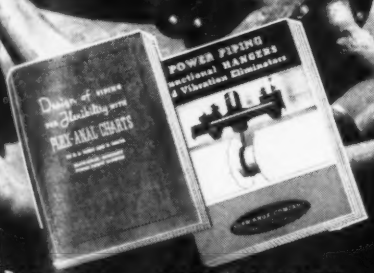
the Fighting Ships



America's ship building industry is utilizing fully the facilities of Blaw-Knox Power Piping Division for Engineering and Erection of

- **PREFABRICATED PIPING**
- **FUNCTIONAL HANGERS** for piping support
- **VIBRATION ELIMINATORS** to control the behavior of piping systems

A shipment of **FUNCTIONAL HANGERS** and **VIBRATION ELIMINATORS** for maritime use



The correlated use of **FLEX-ANAL CHARTS** and **HANGER BULLETIN 1863** saves time in engineering man power which can be devoted to other useful purposes. Copies of these books can be obtained through a request on your business letterhead.

BLAW-KNOX COMPANY
POWER PIPING DIVISION
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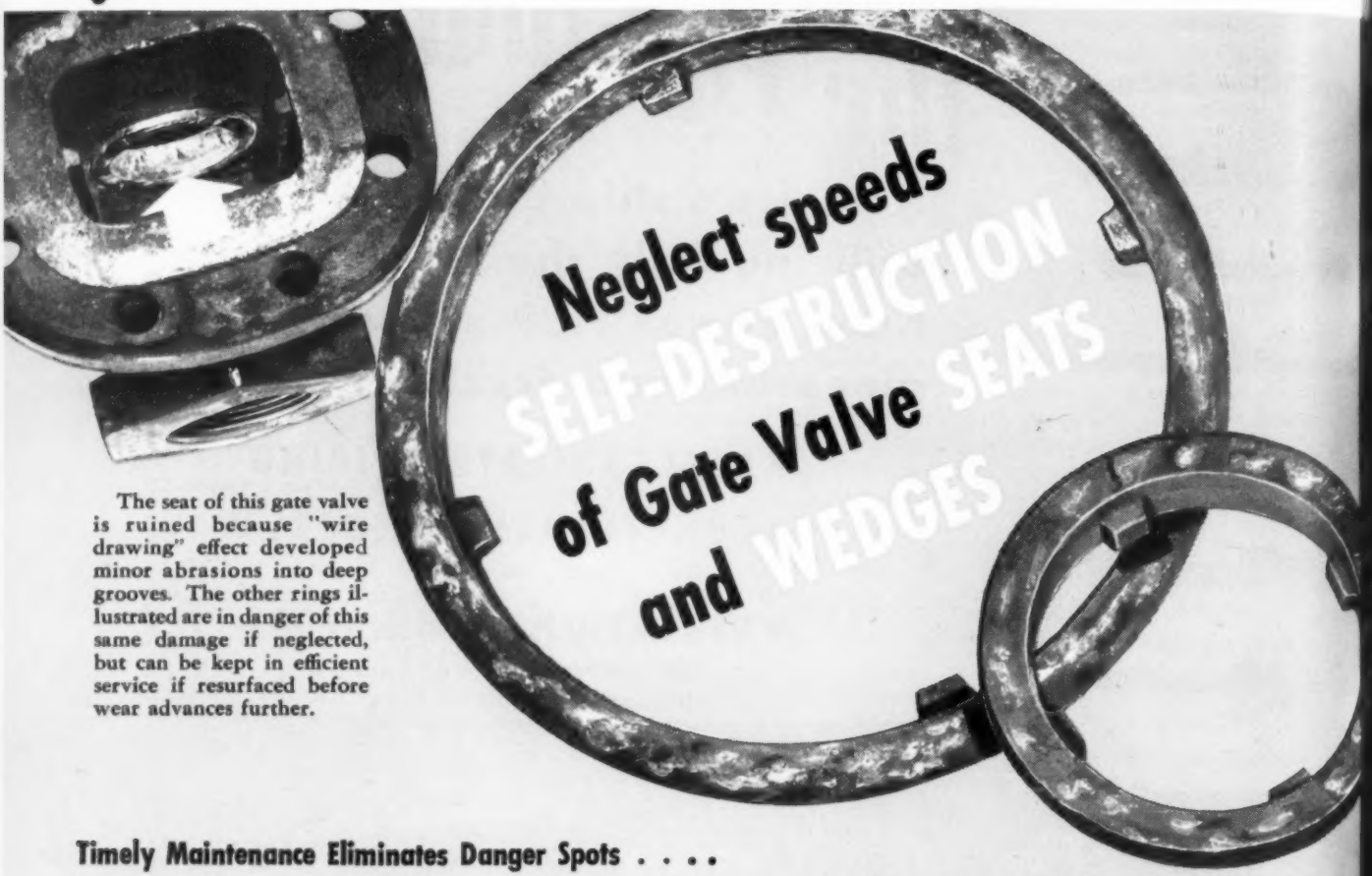
Prevent Valve Failur



The seat of this gate valve is ruined because "wire drawing" effect developed minor abrasions into deep grooves. The other rings illustrated are in danger of this same damage if neglected, but can be kept in efficient service if resurfaced before wear advances further.

Timely Maintenance Eliminates Danger Spots . . . .

Excessive wedge and seat damage in gate valves can usually be traced to their use in throttling service (for which they were never designed) or to the accumulation of foreign matter on the faces. Whatever the primary cause, progressive damage can be arrested, and service life considerably lengthened, by periodic inspections and regular maintenance *in time.*

This "ounce of prevention" is even more essential for gate valves than for other styles. Seat ring replacement in gate valves is an exceptionally difficult operation and should be undertaken only when absolutely necessary. Few repair shops are equipped with the tools and gauges needed to insure proper installation and an absolutely tight valve. It is advisable to return valves 6" and over to the manufacturer for refacing or replacement.

Temporary control of leakage in gate valves can sometimes be accomplished by reversing the wedge, since it is normally the wedge face and seat ring on the outlet end of the valve which are damaged. If the valve is not of the reversible wedge type, the valve itself can be reversed until permanent repairs can be made.

The surest way to keep valves operating efficiently, to keep production going full blast – to prevent slow downs in delivery of goods urgently needed by our armed forces – is to stop valve trouble *before* it starts. Inspect valves frequently . . . repair or replace worn parts in time to prevent valves from destroying themselves . . . select valves carefully, have them installed by experts . . . train maintenance men thoroughly.

Jenkins Engineers will assist any management in preparing an effective program of valve conservation.

Jenkins Bros., 80 White Street, New York 13, N. Y.; Bridgeport, Conn.; Atlanta, Ga.; Boston, Mass.; Philadelphia, Pa.; Chicago, Ill. Jenkins Bros., Ltd., Montreal; London, England.

JENKINS VALVES

BRONZE ★ IRON ★ STEEL

FOR EVERY INDUSTRIAL, ENGINEERING, MARINE, PLUMBING-HEATING SERVI

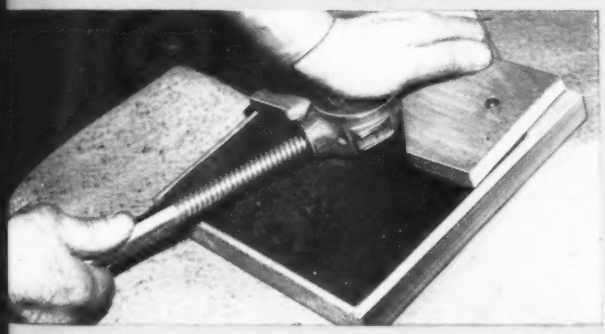
before it starts!

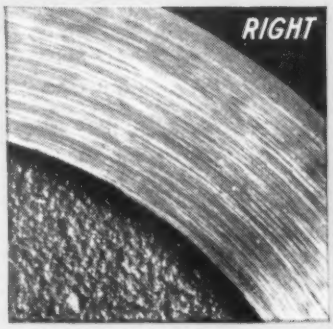
Grinding by hand will resurface seats with minor wear

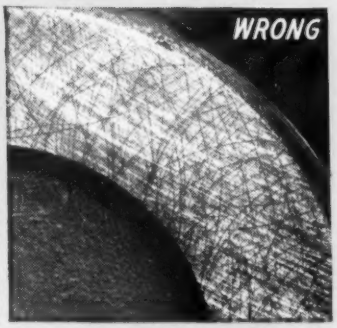
If gate valve seats are only slightly worn or affected, they can be restored by grinding with hand tools as illustrated. A metal plate, fitted with an emery cloth washer, is rotated with a hand brace, in which a universal joint prevents uneven cutting. Special reseating tools are necessary when cuts, grooves or other disfigurements are present.

When refacing seat rings, treat both alike, and remove no more metal than is absolutely necessary. If too much is taken off, the wedge may drop so far between the seats that it touches the bottom of the valve, making a tight closure impossible and necessitating an oversize wedge.

Simple Jig assures Concentric Resurfacing of Wedges



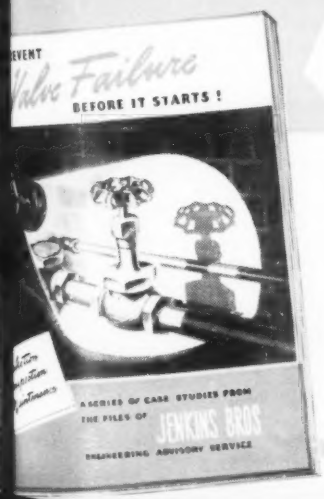




Wedges must be ground carefully to preserve the correct ...r and avoid radial scratches that will invite further ...age. By using the simple bench fixture with a V block ...uide the wedge when it is oscillated about a third of a ...n or so, the concentric facing (see detail marked ...GHT) will be left by the grinding operation. Scratched surfaces of an irregular designed (marked WRONG), which hasten leaks, result from grinding without a guide.

A wedge may be resurfaced simply by holding it against a revolving emery disc affixed to the face plate of a lathe. The wedge should be kept central, and the pressure uniform, to avoid uneven grinding. Wedges worn too badly to be resurfaced by grinding can be turned in a lathe with the use of a face plate of correct taper.

WRITE FOR THIS NEW VALVE CONSERVATION BOOKLET



32 pages . . . 80 illustrations . . . packed with valve-saving suggestions which have appeared in Jenkins advertisements similar to this one. Valuable informaion on valve selection, installation, lubrication, packing, reseating,—on pipe threading, gasket selection, etc. Piping men in every plant should have this booklet. Send for your copy. Fill out and mail the coupon.

JENKINS BROS. 80 White Street, New York 13, N. Y.
Please send me a copy of your new valve conservation booklet – "Prevent Valve Failure Before It Starts".

Name .....

Position .....

Company .....

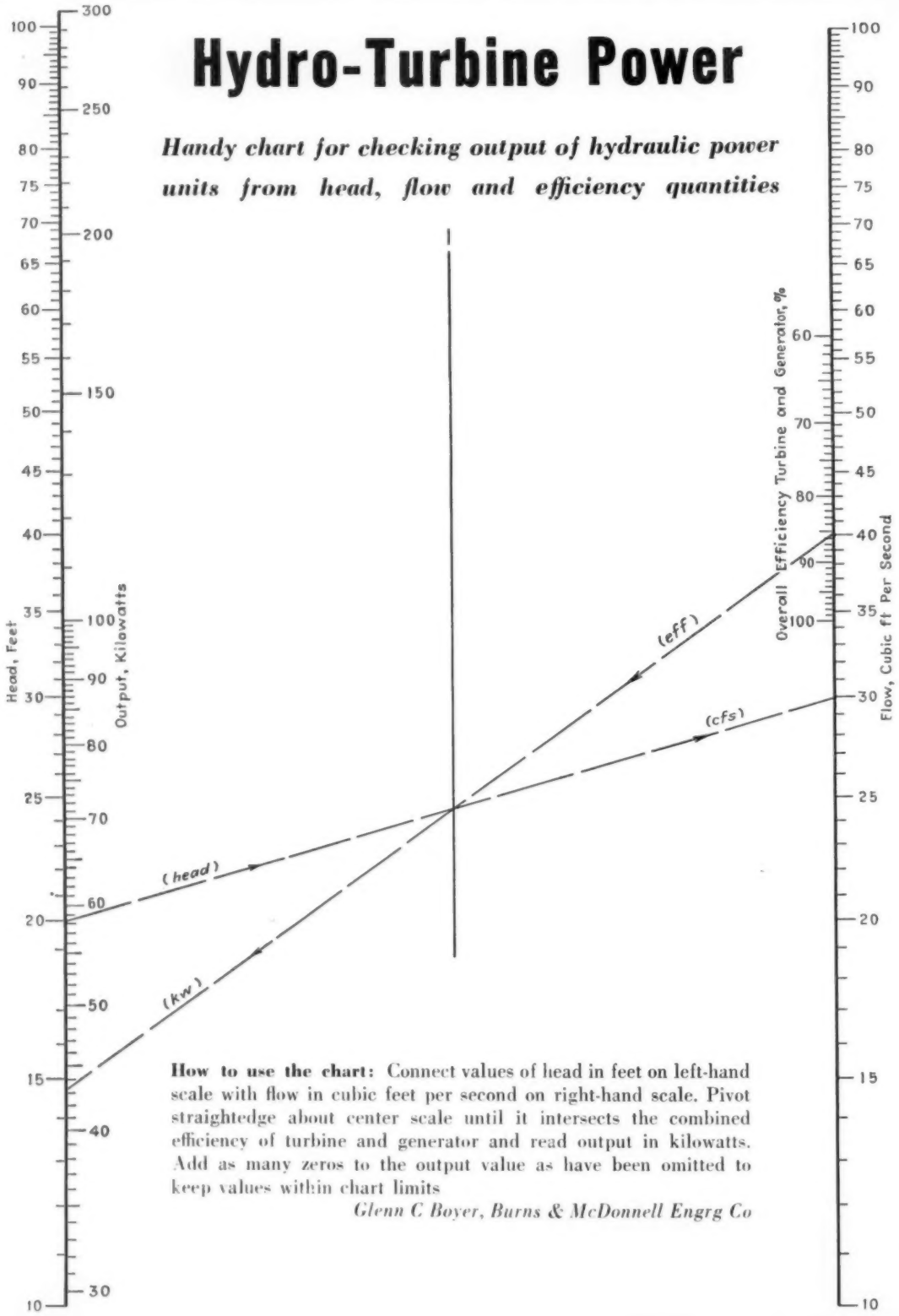
Address .....

.....

Number 140

Hydro-Turbine Power

Handy chart for checking output of hydraulic power units from head, flow and efficiency quantities



How to use the chart: Connect values of head in feet on left-hand scale with flow in cubic feet per second on right-hand scale. Pivot straightedge about center scale until it intersects the combined efficiency of turbine and generator and read output in kilowatts. Add as many zeros to the output value as have been omitted to keep values within chart limits

Glenn C Boyer, Burns & McDonnell Engrg Co

© POWER

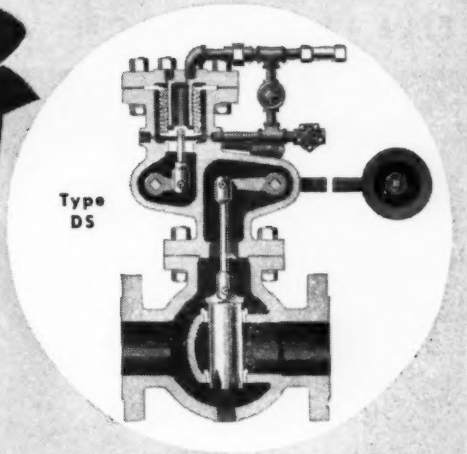
Effective FEED WATER *Control*

BEGINS AT THE PUMP GOVERNOR...

Boiler feed control properly begins at the feed pumps, through maintenance of fixed excess pressures. For this purpose it pays to specify Copes Pump Governors.

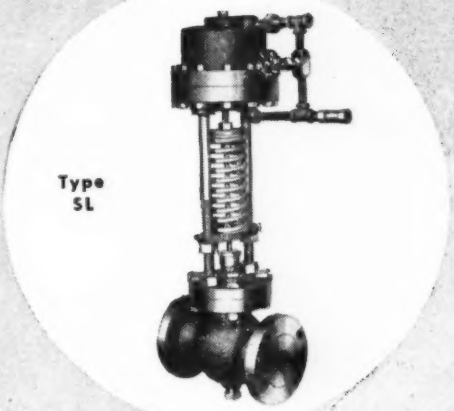
Every Copes Pump Governor is "tailored" to the specific application. This means not only selection of one of nine styles of inner valve fittings, but also design of the port area for existing flow and pressure conditions. Such individualized design results in maximum sensitivity of regulation and minimum wear.

High valve lift, close balance under flow conditions, and sturdiness are "plus" advantage that make Copes Pump Governors a sound investment.



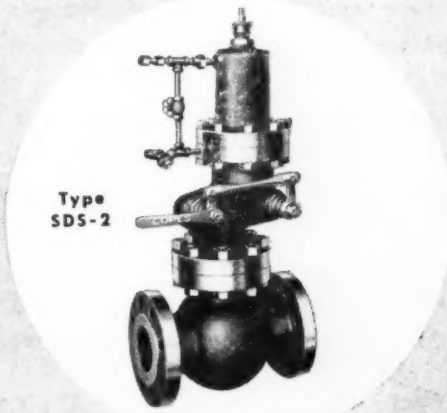
COPES *Type DS Governor*

Service—particularly suited to turbine driven pumps.
Controlled Excess or Constant Pressure Limits—10 to 75 psi.
Sizes—¾- to 4-inch, 250- and 300-lb. stds.
Special Features—Rotating stems, weight loaded, low cost.



COPES *Type SL Governor*

Service—particularly suited to reciprocating steam driven pumps.
Controlled Excess or Constant Pressure Limits—10 to 75 psi.
Sizes—¾- to 3-inch, 250-and 300-lb. stds.
Special Features—Large 4-ply bellows, tight seating inner valve, spring loaded, moderate cost.



COPES *Type SDS-2 Governor*

Service—for severe conditions with any type of pump.
Controlled Excess or Constant Pressure Limits—15 to 150 psi.
Sizes—1½- to 6-inch, 250-lb. std. and up.
Special Features—Rotating stems, large 4-ply bellows, spring loaded, unusually responsive.

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NORTHERN EQUIPMENT CO • 441 Grove Drive, Erie, Pa.

Feed Water Regulators • Pump Governors • Differential Valves
Liquid Level Controls • Reducing Valves and Desuperheaters

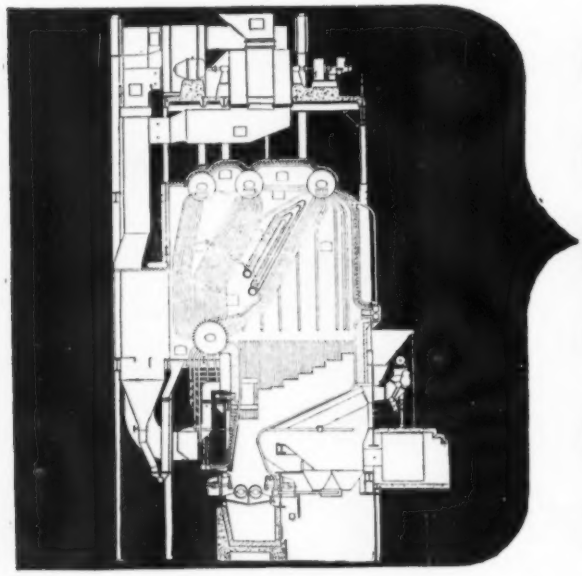
Branch Plants in Canada, England **Representatives Everywhere**

☆ *For* "TAILORED" PUMP GOVERNORS *specify*

COPES

UNION

FILE THESE UNION ADS FOR REFERENCE



H-TYPE
A-TYPE
4-DRUM
RADIANT TYPE
L-TYPE
O-TYPE
LONG DRUM
CROSS-DRUM
UNIVERSAL STEEL-CASED
UNIVERSAL BRICK-SETTING
HORIZONTAL RETURN TUBE
LITTLE GIANT
HEATING

4-DRUM TYPE

UNION BOILER DESIGNERS have a broad background of experience and a large, well-equipped plant to provide the flexibility necessary to build the right boiler for the job. The Union 4-Drum type shown above has many features that skilled boiler men will catch at once.

We are not hidebound at Union. We get a kick out of making the smallest boiler as efficient as possible and have tackled some of the largest boiler jobs issued by Uncle Sam without the slightest hesitation. We'll let the results tell the story. One of the thirteen basic Union designs will meet your steam problem. *Let's have a look at it.*

UNION IRON WORKS ★ ERIE, PA ★

BOILERS

PRESSURE VESSELS • PLATE FABRICATION

The Old Chief

(*Continued from page* 94)

amazed in a cold-eyed way at my ignorance of marine practice. They were mournful about my clumsy way of doing things and when I ventured an opinion about anything, they would look at me with a what-is-the-service-coming-to look, and slowly walk away.

"One day during my watch Chief McLean and the 'Second' were discussing some alterations the owners proposed to make when we reached port. It involved the moving of one of the feed pumps in order to make room for a larger fuel-oil heater. I was all ears to their conversation, especially when the Chief mentioned that it might be advisable to make a drawing of the changes necessary.

The Masterpiece

"Here at last was my chance to show these frozen-faced old buzzards something that would knock their eyes out. As soon as the 'Second' went away I asked the Chief if I might make a drawing of the job for him. He tugged at his mustache for a while. Finally he nodded and walked away without even looking at me.

"I worked on that drawing between every watch without showing it to a soul. I made every line and shading perfect, every arrowhead a work of art. When it was completed, I polished up my buttons and took it to the Chief's cabin. I suspected that he would want to see more of my work, so I took along my prize drawing, just in case. He thanked me for bringing it to him and asked me to be seated while he finished some writing. I admired his room; there were nice easy chairs, plenty of space and a well-stocked bookcase. I figured that this was the beginning of a beautiful friendship. I pictured myself spending many evenings there. I could help the Chief out on drawing technique and possibly he could help me on routine stuff.

"Finally he opened up the drawing and looked at it out of the corner of his eye while he lighted his pipe. When his hands were free he folded it and handed it to me. 'If ye do me a favor, I'll do you one,' he said. 'If you will throw this thing overboard I'll say nothing about it to anyone.'

"'Is there something wrong with it?' I asked in amazement.

"'Well,' he replied, 'you have hooked up the discharge to the return line and the suction to the auxiliary steam, you've moved the manifold into the very place we wish to clear and you've bolted the

SMOOTH

LIGHT-AND-SHADOW TESTS, shown above in Tube Turns' Inspection Department, instantly reveal any rough wall surfaces.

Smooth inner walls are vital in welding fittings. For waves, ridges or "pockets" retard flow, increase pressure loss and accelerate corrosive and erosive action. Absence of surface irregularities permits maximum operative efficiency, reducing maintenance and extending the useful life of any piping system.

Tube-Turn welding fittings are *always* made with uniformly smooth inner walls. Continuous light-and-shadow tests *insure* this superior feature in all Tube-Turn seamless welding fittings.

TUBE TURNS (Inc.) Louisville, Kentucky. *Branch Offices: New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, San Francisco, Seattle. . . . Distributors located in all principal cities.*

ARMY E NAVY M

TUBE-TURN

TRADE MARK

Welding Fittings and Flanges

For V-DAY BUILDING

BENEFIT BY CONNERY V-STIFFENED NON-BUCKLING LEAKPROOF BREECHINGS . . . .

We take pardonable pride in the fact that 100% of Connery output is going to war production projects. And we feel certain that the many plants using (and planning to use) Connery's Improved Expansion Stiffened Construction for stacks, breechings, ducts, etc., won't mind if we give our best to "our first customer," Uncle Sam.

As government priority construction slackens, however, we will be in a position to offer old and new customers specific help on their problems of power plant construction.

STACKS
•
BREECHINGS
•
UPTAKES
•
HOPPERS
•
AIR DUCTS

RECENT INSTALLATIONS

NEW HAMPSHIRE GAS & ELECTRIC CO.	PORTSMOUTH, N.H.
UNITED ILLUMINATING CO.	BRIDGEPORT, CONN.
ROCHESTER GAS AND ELECTRIC CO.	ROCHESTER, N. Y.
INDIANAPOLIS POWER & LIGHT CO.	INDIANAPOLIS, IND.
CONSOLIDATED GAS ELEC. & LIGHT PR. CO.	BALTIMORE, MD.
VIRGINIA PUBLIC SERVICE CO.	ALEXANDRIA, VA.
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CONNERY CONSTRUCTION CO.
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CONNERY
EXPANSION STIFFENED
CONSTRUCTION

pump to a clear space on the bulkhead that does not exist.'

"'Oh,' I said, 'I'll be very pleased to alter that.'

"He held up his hand for silence. 'Young man, I've been in good health for some time now, but I think I will be very sick if I see any more of your drawings.'

"I made my way slowly to the afterdeck rail and in the darkness I indulged in a spell of solid cursing. I questioned the legitimacy of every Scotsman in the world. I called them the most unchristened, bald-headed, poker-faced, uncircumcised, leprous, wheezy, calamitous baboons on the face of the earth. After a while I ran out of suitable adjectives, which fact, together with the cool night air, calmed me down somewhat. Then I gave the Chief credit for not laughing in my face, and for promising not to tell the other men.

"I watched a big liner pass us in the darkness all ablaze with lights, and I wondered if I would ever go to sea again. I slowly took the drawing from my pocket and let it slip through my fingers into the sea. Then I took the prize drawing that I once thought of having framed and let it sail to windward. Next, I threw my silver medal after the drawings for good measure. The smell of strong tobacco warned me that I was not alone and looking up I saw that the Chief was leaning over the rail a few feet away.

A Bit of Advice

"After a while he said, 'Might I give you a little bit of advice, son?'

"I could not trust my voice, so I nodded.

"'This vocation of ours,' he began, 'is an exact and precise business. Idle, irresponsible talk or actions breed mistakes, and mistakes at sea may cost human lives and valuable property. Our responsibilities never escape us. They rest upon everyone on board and we have to be constantly on guard against persons who think they have or pretend to have the knowledge and experience necessary to be trusted with a share in that responsibility.'

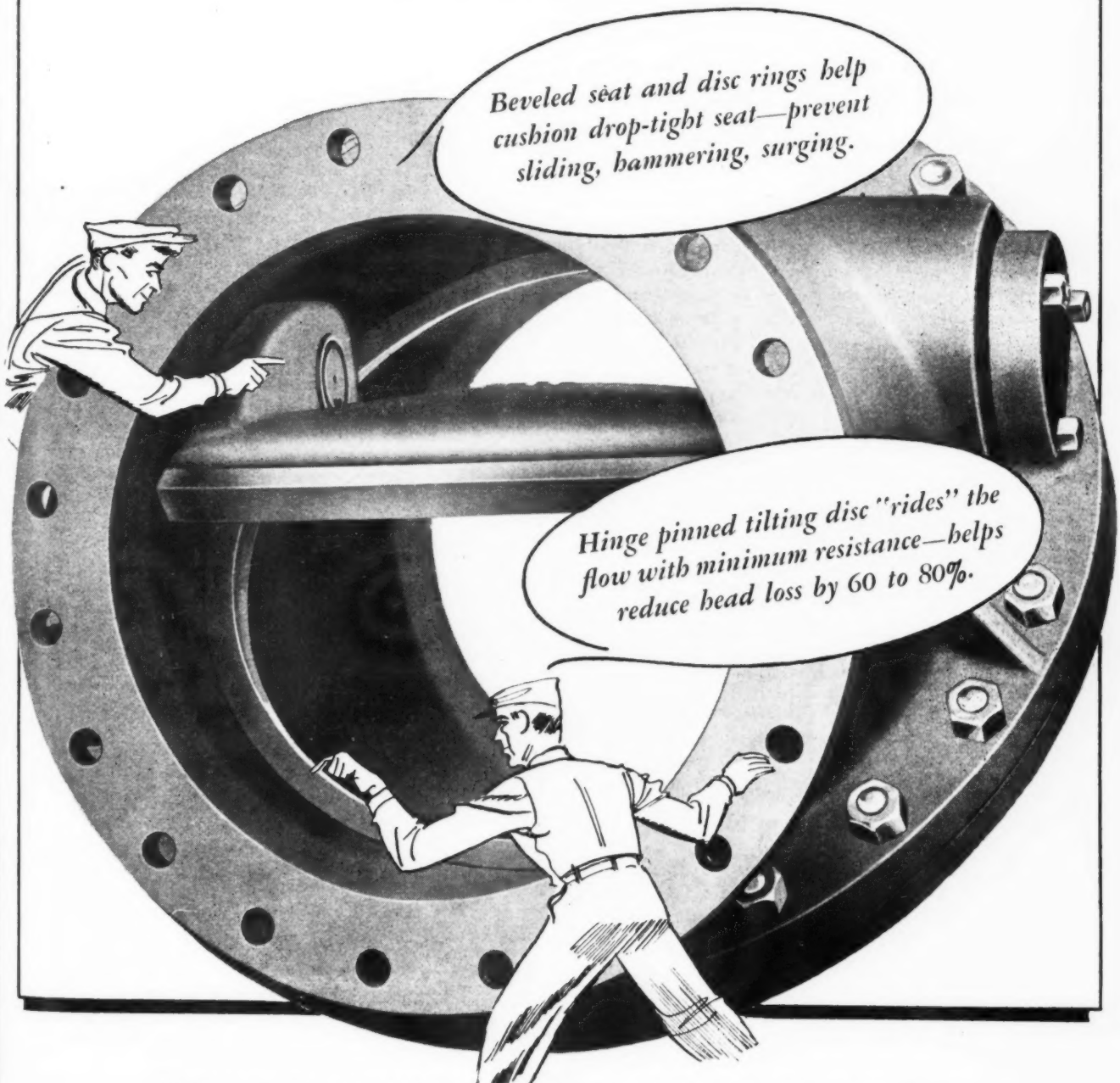
"He puffed at his pipe for a while and continued, 'If you keep your tongue quiet and your eyes and ears open, in due time you will find that you will be accorded recognition in proportion to your reliability, capability and experience. You may also find that seagoing men are not hard to get along with.'

"After he had gone, I walked aft and watched the wash churning behind. I thought that there was a very considerable amount of water between me and the things I had thrown overboard."

LOOK WHAT

CHAPMAN'S AIRFOIL DESIGN

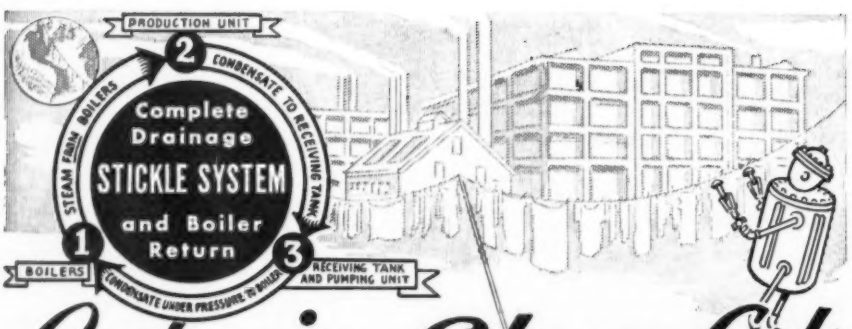
CAN DO FOR YOU!


Beveled seat and disc rings help cushion drop-tight seat—prevent sliding, hammering, surging.
Hinge pinned tilting disc "rides" the flow with minimum resistance—helps reduce head loss by 60 to 80%.

Write today for a copy of Chapman's illustrated Engineering Data Book. Gives you complete information on how Tilting-Disc Check Valves improve your plant operation and cut costs far beyond ordinary swing-type checks. The Chapman Valve Manufacturing Company, Indian Orchard, Massachusetts.

CHAPMAN NON-SLAM CUSHIONED CLOSING **CHECK VALVES**

Equally efficient on horizontal or vertical installations on water, steam, oil, gas and air lines



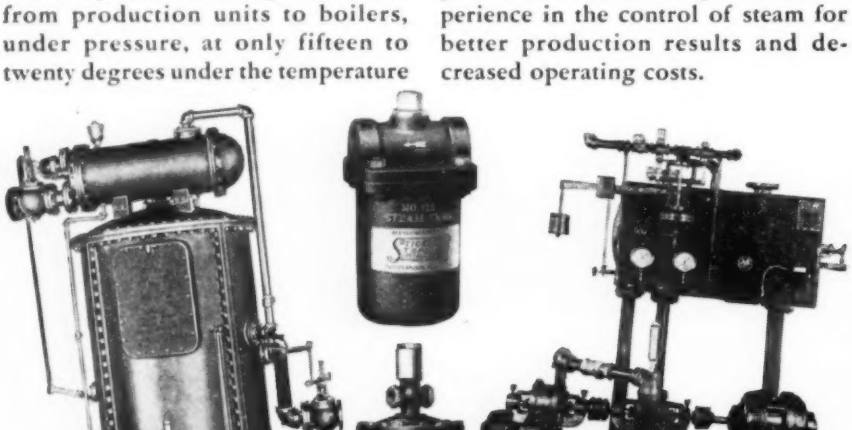
Reducing Steam Costs for LAUNDRIES

For Dry Cleaning Plants and Other Industries Using Process Steam

Cutting fuel costs twelve, fifteen and up to twenty per cent. Increasing boiler capacity in ratio to fuel saving. Eliminating fluctuations and maintaining higher operating temperatures. Increased production of better quality from drying tumblers, ironers and presses.... These are results now being obtained by laundries where the Stickle Differential Drainage and Boiler Return System is being used—with additional saving in maintenance due to elimination of high velocities.

This system, returning condensate from production units to boilers, under pressure, at only fifteen to twenty degrees under the temperature of steam at operating pressures, is proving its extraordinary value in many other types of industry, such as canning, milk drying, box board and corrugated paper manufacturing and sand drying, in which steam at medium and high pressures is used for processing operations.

Stickle Equipment including steam traps, regulating and reducing valves, feed water heaters and other specialties; as well as complete systems for laundries, canning plants, paper mills and other industries represents the practical translation of specialized experience in the control of steam for better production results and decreased operating costs.



Bulletins for complete information: No. 250—Differential Drainage and Boiler Return System. Nos. 115 and 315—Stickle Open Float Steam Traps. Nos. 235 and 435—Stickle Reducing and Regulating Valves. No. 117—Stickle Open Coil Feed Water Heaters and Purifiers.

Stickle

STEAM SPECIALTIES COMPANY

2265 VALLEY AVENUE • INDIANAPOLIS, INDIANA

SPECIALIZING FOR 40 YEARS IN REDUCING THE COST OF STEAM

Questions and Answers

(*Continued from page* 120)

tory classification system for all coal.

In general there are three main coal classes: anthracite, bituminous and lignite, but no clear-cut line exists between them, and we have other coals classed as semi-anthracite, semi-bituminous and sub-bituminous. Anthracite is the oldest coal, geologically speaking. It is a hard coal composed mainly of carbon with little volatile content and practically no moisture. Coming up the scale towards the youngest coal (lignite), carbon content decreases and volatile and moisture increases.

Fixed carbon refers to carbon in its free state, not combined with other elements. *Volatile* matter refers to these combustible constituents of coal that vaporize when coal is heated.

Q 20—*What are the approximate heat values of the various classes of coal?*

A—Because of the wide variation in composition it is impossible to give definite figures for each class. Generally speaking, the heat value varies from as low as 7000 to 8000 Btu per lb for lignite to around 1500 Btu per lb for high-grade bituminous.

Q 21—*What is meant by pulverized coal?*

A—This is coal ground to a fine powder before being fed into the furnace. It is blown into the furnace by a strong blast of air and burns in much the same manner as gas.

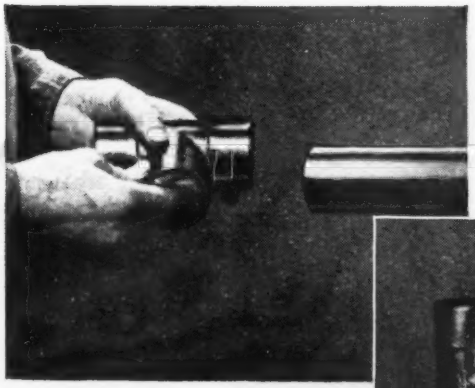
Q 22—*What is the average composition and heat value of wood?*

A—Heat value of wood depends largely upon its moisture content. This may run as high as 50% in green wood. Even seasoned wood contains 15 to 25% moisture—about 8% for kiln dried.

The heat value of perfectly dry wood is about 8500 Btu per lb. The same wood with 25% moisture would run about 6400 Btu per lb. Sawdust has much the same heat value as the wood from which it is cut.

Q 23—*What is the average composition and heat value of fuel oil?*

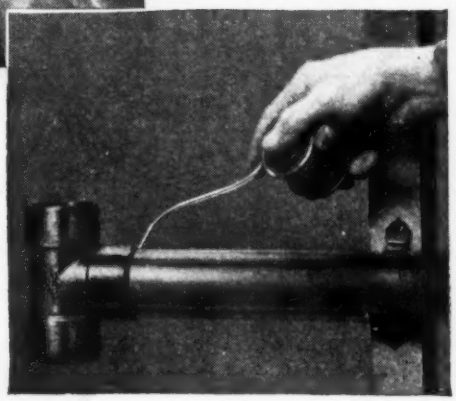
A—Fuel oil may be crude oil direct from the well, but is commonly the residue left after the lighter oils, such as gasoline and naphtha, have been distilled from the crude. It is composed mainly of hydro-carbons (compounds of hydrogen and carbon) with small quantities of moisture, sulphur, oxygen



Saw tube square and remove burrs. Clean outside of tube and inside of fitting with steel wool.

Apply soldering flux on tube end and revolve fitting to spread. Apply heat to the fitting, testing with solder.

3 EASY STEPS in assembling Strong-Sound-Leakproof Copper Tube Pipelines

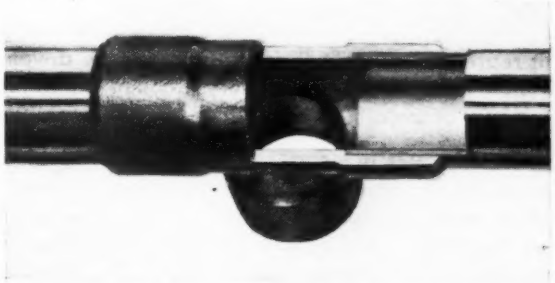


At correct temperature (when solder melts) feed the solder to edge of fitting. Remove excess solder with cloth or brush, leaving fillet.

EXPERIENCE HAS SHOWN that copper tube lines can be installed in approximately half the time required for threaded pipe. Cost of these tubes, installed, is low due to speed of assembly and the relatively light weight made possible by the elimination of threading.

Copper tubes offer additional advantages: Pumping costs are lower because their smooth interiors are less resistant to flow. They are rustproof . . . save space . . . bend readily. In the event of changes in plant layout, copper tube lines may be disassembled and reinstalled with a minimum of expense.

Many a busy plant today is benefiting from the prewar prudence of those who specified copper tubes for piping. It will pay you to look ahead to the time when this worthwhile piping is again generally available. Publication C-24, sent on request, describes industrial applications of Anaconda Copper Tubes, in nominal sizes from ⅛″ to 12″ inclusive. 4459



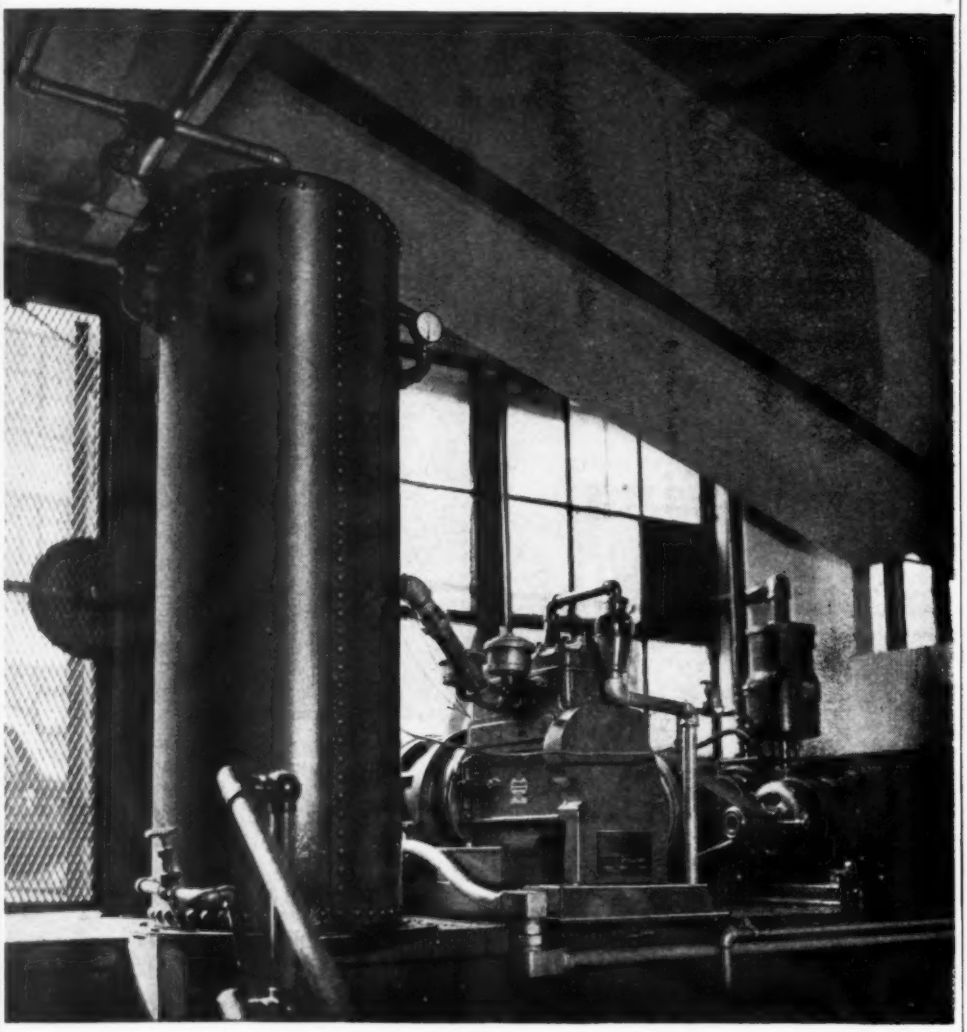
Cutaway section showing completed joint of Anaconda Tube and Cast Solder Fitting. Note generous depth of cup and accurate fit at end of tube.

ANACONDA *Anaconda Copper Tubes*

THE AMERICAN BRASS COMPANY, General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company • *In Canada:* ANACONDA AMERICAN BRASS LTD., *New Toronto, Ontario*

SCHRAMM COMPRESSORS ARE *BALANCED* TO ELIMINATE VIBRATION



HERE'S an installation showing just what can be done with an "easy-to-install," compact Schramm air compressor.

The unit represents a "utility" compressor directly driven from 20 HP Electric motor . . . installed on an ordinary wooden platform, which was made possible because of smooth, vibration-free operation.

Schramm compressors are available with various types belt drives, as well as built-in motor drive and direct connected diesel or gasoline engines. Other features that assure you plenty of air include: (1)—completely watercooled (2)—forced feed lubrication (3)—easy to start (4)—mechanical intake valve (5)—sturdy support for cylinder heads.

Specify Schramm Air Compressors in your plant and get heavy-duty continuous operation with least attention, upkeep and operating costs.

Write for full data in Catalog 42-S.

SCHRAMM INC. THE COMPRESSOR PEOPLE WEST CHESTER PENNSYLVANIA

and nitrogen. The following is a typical analysis:

Carbon	84%
Hydrogen	13%
Sulphur	1%
Oxygen	1%
Nitrogen	1%

Heat value is approximately 19,000 Btu per lb.

Q 24—*What is composition and heat value of natural gas?*

A—Natural gas is composed mainly of hydro-carbons, such as methane, (CH_4), and ethane, (C_2H_6), with small amounts of carbon dioxide, (CO_2), oxygen, (O_2), nitrogen (N_2), and sometimes hydrogen sulphide (H_2S). The following is a typical analysis:

Methane	80.2%
Ethane	17.3%
Nitrogen	2.3%
Oxygen	0.2%

The average high heat value is around 1000 Btu per cu ft, measured at 14.7 psi and 60 F.

Q 25—*What are the combustible elements in fuels?*

A—The combustible elements are carbon, hydrogen and sulphur.

Q 26—*What are the non-combustible elements in fuels?*

A—The non-combustible elements are nitrogen and those elements that make up the moisture and the ash.

Q 27—*What element in fuels is harmful to metals?*

A—Sulphur is harmful as it will combine with condensate to form sulphurous and sulphuric acids (H_2SO_3) and (H_2SO_4), which have a corrosive action on iron and steel.

Q 28—*What are the products of the complete combustion of carbon, hydrogen and sulphur?*

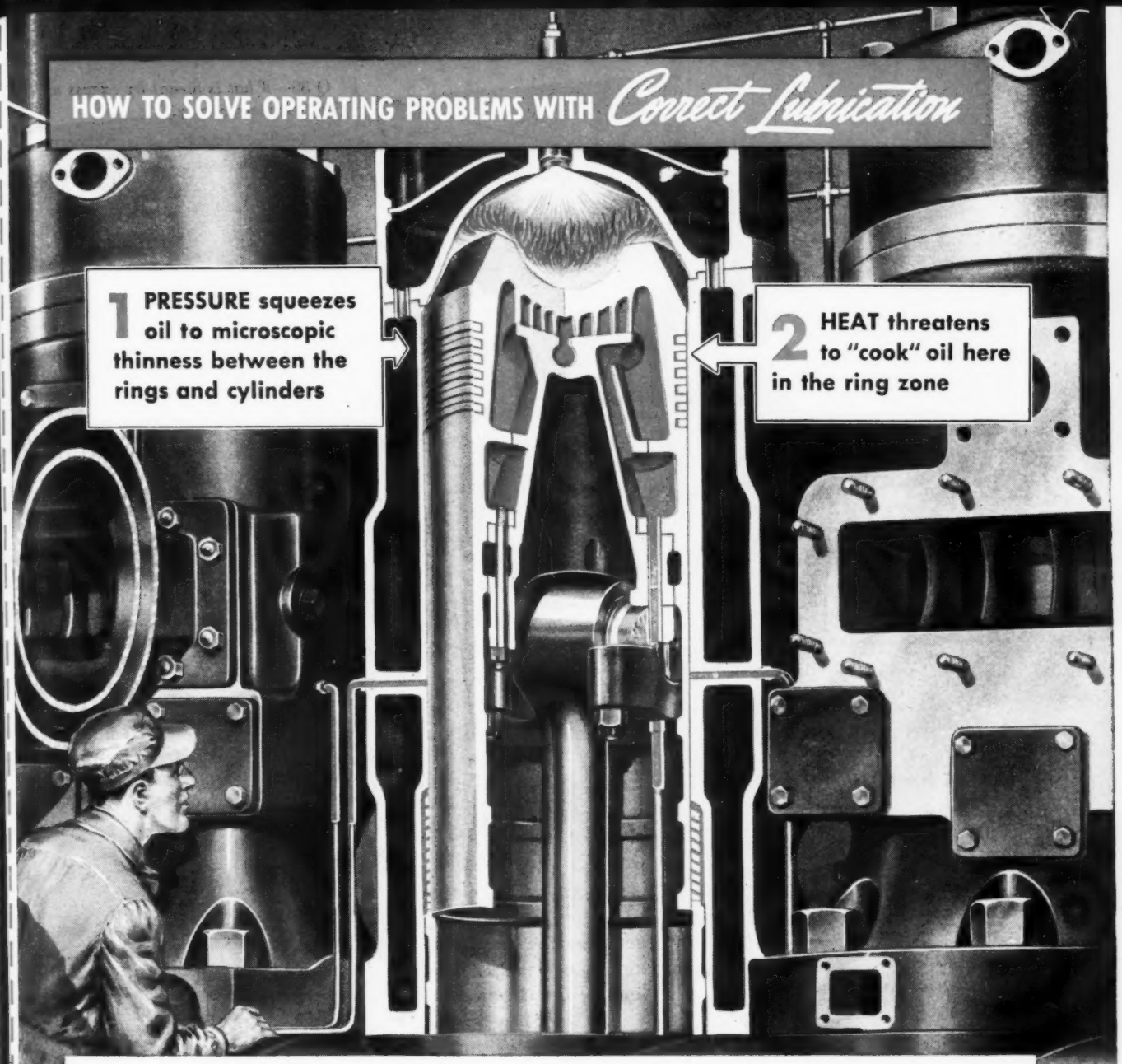
A—If burned with a sufficient supply of oxygen, carbon will burn to carbon dioxide (CO_2), hydrogen will burn to water vapor (H_2O), and sulphur will burn to sulphur dioxide gas (SO_2).

Q 29—*What are the products of the incomplete combustion of carbon, hydrogen and sulphur?*

A—If the supply of oxygen is insufficient for complete combustion, only part of the hydrogen and sulphur will be burned to H_2O and SO_2; the rest will pass off unchanged. If burned with an insufficient supply of oxygen, carbon will burn to carbon monoxide (CO), instead of CO_2. This carbon monoxide is a combustible gas and is also highly poisonous.

(*Continued on page* 144)

HOW TO SOLVE OPERATING PROBLEMS WITH *Correct Lubrication*


1 PRESSURE squeezes oil to microscopic thinness between the rings and cylinders
2 HEAT threatens to "cook" oil here in the ring zone

Stop this Double Threat to Power

SEE THOSE light red areas in the Diesel engine picture above. They represent the lubricating oil films that protect the pistons, cylinders and rings.

These films are your defense against pressure and heat—the double threat to power in your engine. If they fail under the crushing pressure, excessive wear follows. If they "cook" in the terrific heat of the ring zone, hard deposits form and the rings stick. Blowby occurs . . . you lose power.

Gargoyle D.T.E. Oils for Diesel engines give you double protection against this double threat. Their strong films resist metal-to-metal contact, even though they are squeezed to microscopic thinness, and they prevent the formation of hard deposits in the all-important ring zone.

Your engine stays clean. You get full power with full protection all the time.

GARGOYLE Lubricants

SOCONY-VACUUM OIL CO., INC., Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. • White Eagle Div. • Wadhams Div. • Magnolia Petroleum Company • General Petroleum Corporation of California.

CALL IN SOCONY-VACUUM

DEPENDABLE, LOW-COST
SANTOSITE
IS INSURANCE AGAINST

OXYGEN CORROSION

EVEN though you are using mechanical deaerating equipment efficiently, the addition of Santosite to boiler feed water will give low-cost insurance . . . and positive protection . . . against damaging oxygen corrosion. Such protection is necessary because overloads, leakage of air into the system and small amounts of oxygen not eliminated by mechanical equipment may add up to dangerous amounts of dissolved oxygen in the boiler water.

Maintaining 30 parts of Santosite per million parts of water *in the boiler* has been found ample protection against oxygen corrosion in any type of plant. Santosite eliminates oxygen by combining with it to form sodium sulfate. Since both Santosite and sodium sulfate are soluble in water, there is no objectionable sludge.

Santosite, a stable crystalline anhydrous product, is easy to handle and store. It can be applied with standard chemical solution feeders.

A simple chemical test, a type familiar to boiler room foremen, easily determines the amount of Santosite in boiler water. Unusual consumption of the chemical, revealed by these tests, may be your first indication of leaks in the system or trouble developing in auxiliary equipment.

We shall be happy to cooperate with you in working out the efficient application of Santosite to your boiler feed water. Please write: MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, St. Louis 4, Missouri. District Offices: New York, Chicago, Boston, Detroit, Charlotte, Birmingham, Los Angeles, San Francisco, Montreal, Toronto.

MONSANTO CHEMICALS
SERVING INDUSTRY . . . WHICH SERVES MANKIND

Q 30—*What is meant by excess air, and why is it necessary?*

A—The amount of air *theoretically* necessary to burn a fuel completely can be calculated from the ultimate analysis of the fuel, but in practice we must introduce more air into the furnace than the theoretical amount, to make sure that all the combustible elements of the fuel receive enough oxygen for complete combustion.

Q 31—*What are the usual percentages of excess air admitted to boiler furnaces with*

(1) Coal—hand fired
(2) Coal—stoker fired
(3) Oil, gas or powdered fuel

A—(1) With hand firing:
a. Under good conditions—50%
b. Under poor conditions—100% and over
(2) With mechanical stokers—20 to 50%
(3) With oil, gas or powdered fuel—10 to 30%

Q 32—*What are the disadvantages of using large amounts of excess air?*

A—This excess air does not take part in combustion, but absorbs and carries off heat from the furnace to the chimney, thus lowering the efficiency of the steam generating unit.

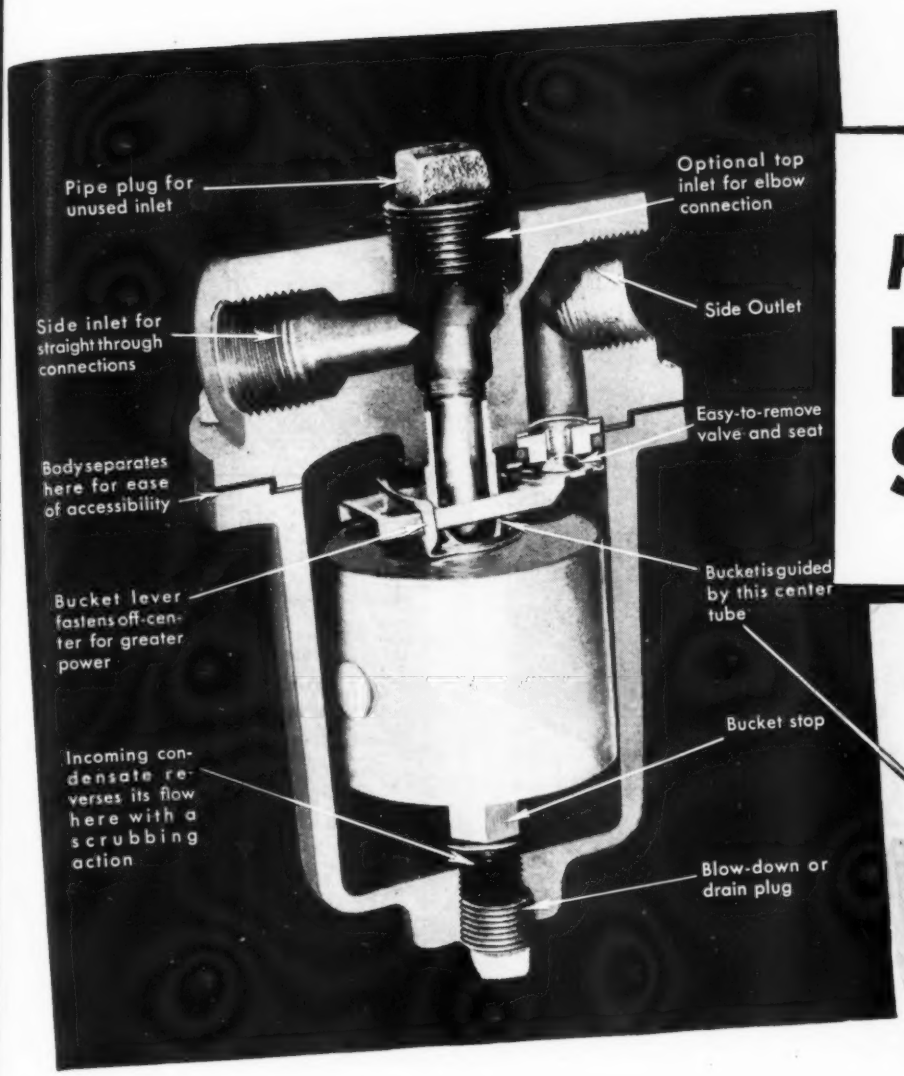
Q 33—*What methods are used to analyze coal?*

A—There are two methods: the *ultimate analysis* splits up the fuel into all its component elements, solid or gaseous; and the proximate analysis determines only the fixed carbon, volatile matter, moisture and ash percentages. The first must be carried out in a properly equipped laboratory by a skilled chemist, but the second can be made with fairly simple apparatus. Note that "proximate" has no connection with "approximate."

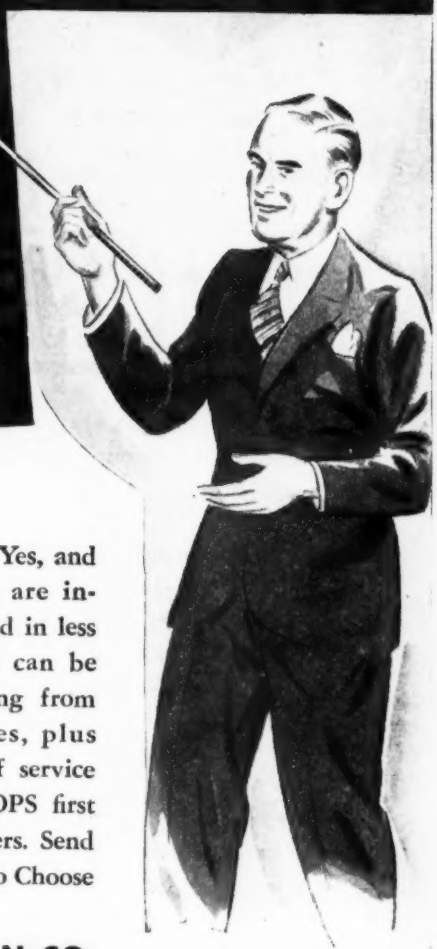
Q 34—*Explain how a proximate analysis is made.*

A—*To determine moisture:* Crush a sample of raw coal until it will pass through a 20-mesh screen (20 meshes per lineal inch), weigh out a definite amount, place it in a covered crucible and dry in an oven at about 225 F for one hour. Then cool sample to room temperature and weigh again. The loss in weight represents moisture.

To determine volatile matter: Weigh out a fresh sample of crushed coal, place in a covered crucible and heat over a large bunsen burner until all the volatile gases are driven off. Cool the sample and weigh. Loss of weight represents moisture and volatile matter. The


Pipe plug for unused inlet
Optional top inlet for elbow connection
Side Outlet
Side inlet for straight through connections
Easy-to-remove valve and seat
Body separates here for ease of accessibility
Bucket is guided by this center tube
Bucket lever fastens off-center for greater power
Bucket stop
Incoming condensate reverses its flow here with a scrubbing action
Blow-down or drain plug

Here's the INSIDE STORY



● The inside story of SUPER-SILVERTOPS quickly tells why these Steam Traps are unsurpassed in efficiency and economy. Here are features not found in any other trap. Note the simplicity of construction, the smooth passages that cannot become clogged with dirt and scale —the guided bucket and the easy-to-remove valve and seat. Equally important are the side and top inlets and outlet construction which permits this trap to be piped as an elbow or straight-in-line. Yes, and Anderson Super-Silvertops are installed with less fittings and in less time—furthermore, they can be inspected without removing from the line. These features, plus longer, trouble-free life of service makes SUPER-SILVERTOPS first choice of Steam Trap users. Send today for the book, "How to Choose a Steam Trap."

THE V. D. ANDERSON CO.
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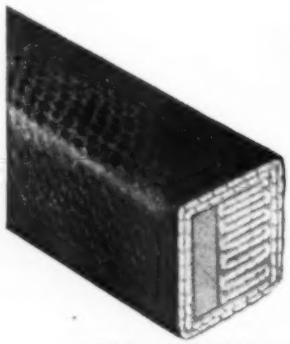
Super-Silvertop
STEAM TRAPS

BELMONT PACKINGS



FOR RECIPROCATING STEAM RODS

Belmont 30

For reciprocating steam rods where boiler temperature is in excess of 100 lbs. (340 degrees F.)

FOR ROTATING SHAFTS

Belmont 754 P

For all types of centrifugal and rotary conditions, as well as oscillating rods.

FOR STEAM

Today, the war demands uninterrupted service of power plant equipment. Engines and pumps must be kept operating at maximum capacity—there is no time for frequent packing replacements.

Leaking valves . . . pistons . . . rods and plungers cause power losses which cut serious inroads into production.

Check now the packing in your stuffing boxes—at points of service—at prime movers—put the right packing on each job to avoid unnecessary delays through equipment failures.

Above we illustrate two standard Belmont Packings for steam services. Belmont High Pressure Packing No. 30 is indicated wherever a packing is needed for high pressure steam rods, expansion joints, air and gas services.

For centrifugal and rotary shafts working against steam, water, oil and weak acids Belmont 754 P can be considered a standard packing.

Belmont distributors are located in every large industrial center, or write on your company letterhead for a copy of the Belmont Packings Catalog and see the complete Belmont Line in detail.

THERE'S A BELMONT PACKING FOR EVERY SERVICE

Steam, Water, Oil, Gas, Air, Acids, Alkalies, Ammonia. Forms include: Rings, Spirals, Coils, Reels, Spools, Sheets, Gaskets.

THE BELMONT PACKING & RUBBER COMPANY

BUTLER & SEPVIVA STREETS • PHILADELPHIA 37, PA.

remainder is coke (fixed carbon and ash).

To determine carbon and ash: Remove the cover from crucible used in the last test and heat the crucible over the bunsen burner until all the carbon is burned. Cool and weigh the residue, which is the incombustible ash. Difference in weight from the previous weighing will be the fixed carbon.

Q 35—*Of what value is a fuel analysis* to the engineer?

A—It enables the engineer to compare one fuel with another on the basis of moisture, ash and combustible matter.

Safe Flywheels

(*Continued from page* 89)

the modulus of rupture in bending for the bending stress and 19,000-psi ultimate tensile stress for the hoop-tension component.

Knowing the probable bursting velocity of a solid wheel of given proportions based on centrifugal stress, it is simple to apply a factor of safety on speed to take care of the working and extraneous stress due to torque effort, inertia, casting shrinkage and impact forces. A factor of safety of 3½ on speed, for example, represents a factor of safety on stress of over 12, 4 on speed, 16 on stress, etc.

Example I: A solid cast-iron pulley wheel, diameter 8 ft, rim thickness 1.75 in., rim width 15 in., mean spoke-section area 15 sq in., has six spokes.

$$\text{Ratio } K = \frac{15}{1.75 \times 15} = 0.57$$

$$\text{Ratio } M = \frac{96}{1.75} = 54.7$$

Bursting velocity from Fig. 4 is 270 ft per sec. If a factor of safety of 3½ is required, maximum safe rim speed is 77.2 ft per sec or

$$\frac{77.2 \times 60}{8 \times 3.14} = 184 \text{ rpm.}$$

The allowable speed based on the 100-ft-per-sec rule would have been 238 rpm.

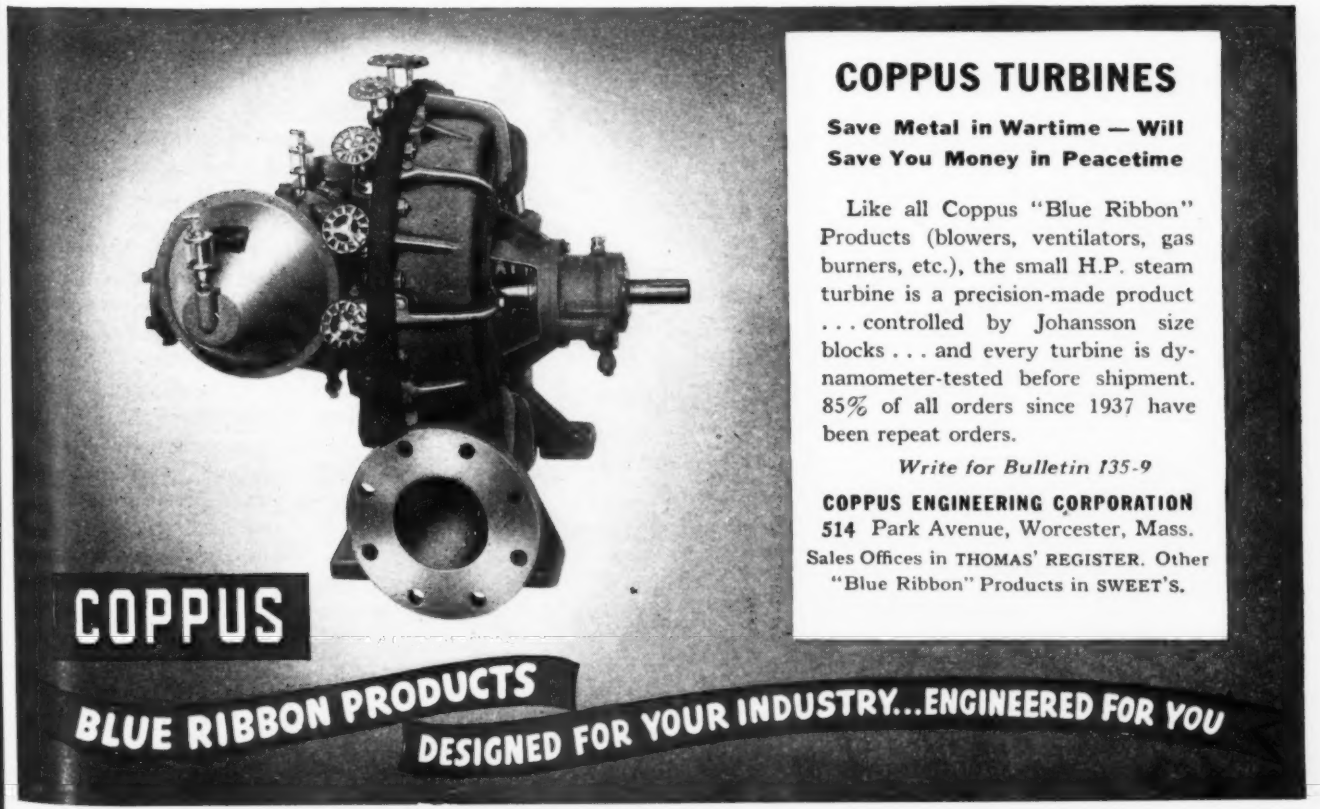
Example II: A solid cast-iron flywheel, diameter 8 ft, rim thickness 10 in., rim width 12 in., has six spokes each with a mean sectional area of 48 sq in.

$$\text{Ratio } K = \frac{48}{10 \times 12} = 0.4$$

$$\text{Ratio } M = \frac{96}{10} = 9.6$$

Bursting velocity from Fig. 4 is 419 ft per sec. With the same factor of safety, as for Example I, 3½, permissible rim

A steam turbine needs a big frame to develop Elephant Power . But if you need only Horsepower, a COPPUS Steam Turbine saves money and metal . Six sizes from 150 Horsepower down to fractional. Each smaller size has smaller frame requires less metal and is priced less . Each is a COPPUS Blue Ribbon Turbine so you get top quality while saving money and metal .



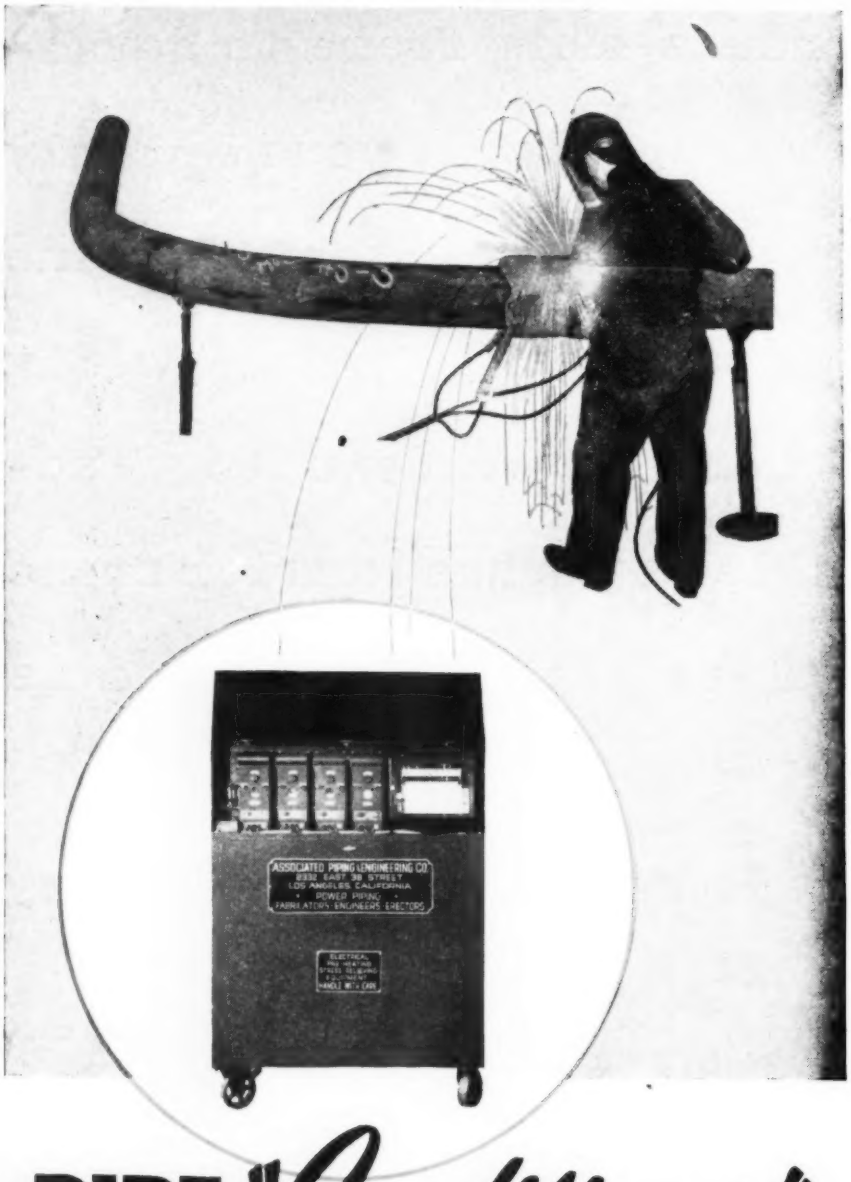
COPPUS TURBINES

Save Metal in Wartime — Will Save You Money in Peacetime

Like all Coppus "Blue Ribbon" Products (blowers, ventilators, gas burners, etc.), the small H.P. steam turbine is a precision-made product . . . controlled by Johansson size blocks . . . and every turbine is dynamometer-tested before shipment. 85% of all orders since 1937 have been repeat orders.

Write for Bulletin 135-9

COPPUS ENGINEERING CORPORATION
514 Park Avenue, Worcester, Mass.
Sales Offices in THOMAS' REGISTER. Other "Blue Ribbon" Products in SWEET'S.



PIPE "Conditioner" before and after

The unit shown above was designed by Associated engineers to automatically and accurately record and control temperatures in pre-heating, stress-relieving operations for high-temperature, high-pressure fabrications. Piping so conditioned before and after welding is greatly protected from possible structural injury often due to improper heat application. . . . Skill, knowledge, equipment and accomplishments distinguish Associated in the field of industrial piping.

ASSOCIATED PIPING & ENGINEERING CO., Inc.
2332 East 38th Street • Los Angeles 11, California

ASSOCIATED *Progressive* **PIPING**

speed would be 119 ft per sec, or 283 rpm. The 100-ft-per-sec rule would have limited this wheel to 238 rpm.

Actual bursting speeds of Professor Benjamin's nine 6-spokes solid wheels ranged from 97 to 125% of chart values, averaging 112%. This is accounted for by a 19,600-psi tensile and 48,000-psi rupture modulus reported for the cast iron of the test flywheels, somewhat greater than the conservative chart values.

If rimmed pulley wheels have flanges or a strengthening web at the center, calculate ratio M using the net thickness plus one quarter of the flange depth. This usually increases the net thickness by about 75%. Areas of elliptic-spoke sections are readily determined by taking 78.5% of width times thickness. The *actual* rim cross-section area is used in calculating K.

For bolted-flange wheels, the eight reported in the Benjamin tests burst at an average of 52% of chart values for solid rims (three at 53.5%, four at 52.2% and one at 45%). From these tests, a rim with bolted flanges can be expected to burst at one half the velocity of the chart value for a similar wheel without flanges. Based on only two shrink-link wheels, the corresponding ratio for this type is 78%. One segmental-rim wheel burst at 62% of the corresponding chart value.

Off-Season Job

(*Continued from page* 106)

If the cylinders are in good condition it usually follows that the pistons are in equally good shape. What has been said about grooves and marks in the cylinders applies here as well. Piston body must be absolutely smooth before it is replaced. Most important is the condition of rings whose natural wear should be measured and recorded from year to year. For a 10-in. piston, a minimum end clearance of 0.025 to 0.030 in. (depending on the shape of the ends), Fig. 6, and a minimum side clearance of 0.0025 in. should be allowed, or the rings may jam and score the cylinder walls.

Rings should bear against the cylinder walls with from 3 to 5½ psi; the opening between ends of a 10-in. ring, when released, is about ⅝ in. In spite of proper side clearance a ring may stick even after it and the piston have been cleaned and every trace of foreign matter removed with high-pressure air. Such a ring must be removed and replaced by

"F & E" Stokers

FIRE 1006 BOILER HORSEPOWER AT HOFFMAN-LA ROCHE, INC.

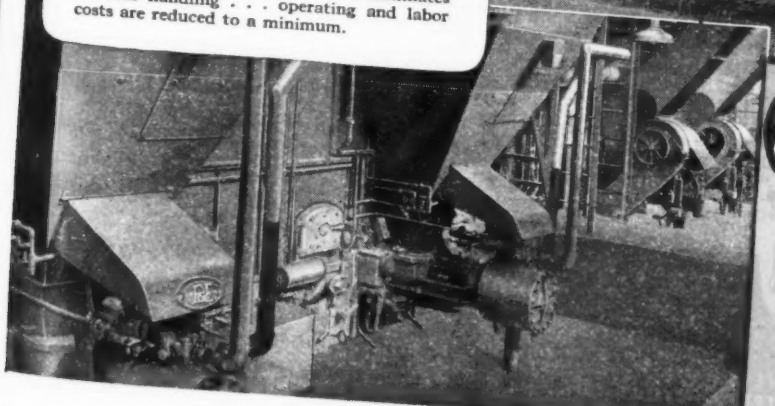
Power must not fail in the plant of Hoffman-La Roche, Inc., Roche Park, Nutley, N. J., for in this plant are manufactured vital medicines and vitamins to help keep Americans healthy.

Four "F & E" Underfeed Stokers . . . 2 Series 70 Steam Ram Drive and 2 Series 60 Unit type, Electro-Hydraulic Ram Drive . . . have furnished dependable power for over two years, a major factor in the enormous and still expanding production of this plant. Normal rating of the four boilers totals 1006 H.P., total steam capacity of stokers 72,000 lbs. per hr. Ordinary run of nut and slack bituminous coal is used.

Hoffman-La Roche, Inc., is only one of many hundreds of production-minded companies who are experiencing the dependability and economy of "F & E" Underfeed Stokers. Is your company one of them?

All you need do to find out what "F & E" Stokers can do for you is to talk to your own consulting engineer or see the "F & E" representative in your territory.

Administration building of Hoffman-La Roche, Inc., Roche Park, Nutley, N. J.



View of boiler room. The two B & W stokers in the foreground are Series 70 Steam Ram Drive, installed under B & W Cross Drum, 303 H.P. boilers. The two stokers in the background are Series 60, Unit Type Electro-Hydraulic Steam Ram Drive, installed under 200 H.P. HRT boilers.

A complete coal conveyor system eliminates all coal handling . . . operating and labor costs are reduced to a minimum.

F&E STOKERS

for boilers producing from 1000 to 40,000 lbs. of steam per hour

are manufactured by

FLYNN & EMRICH CO.

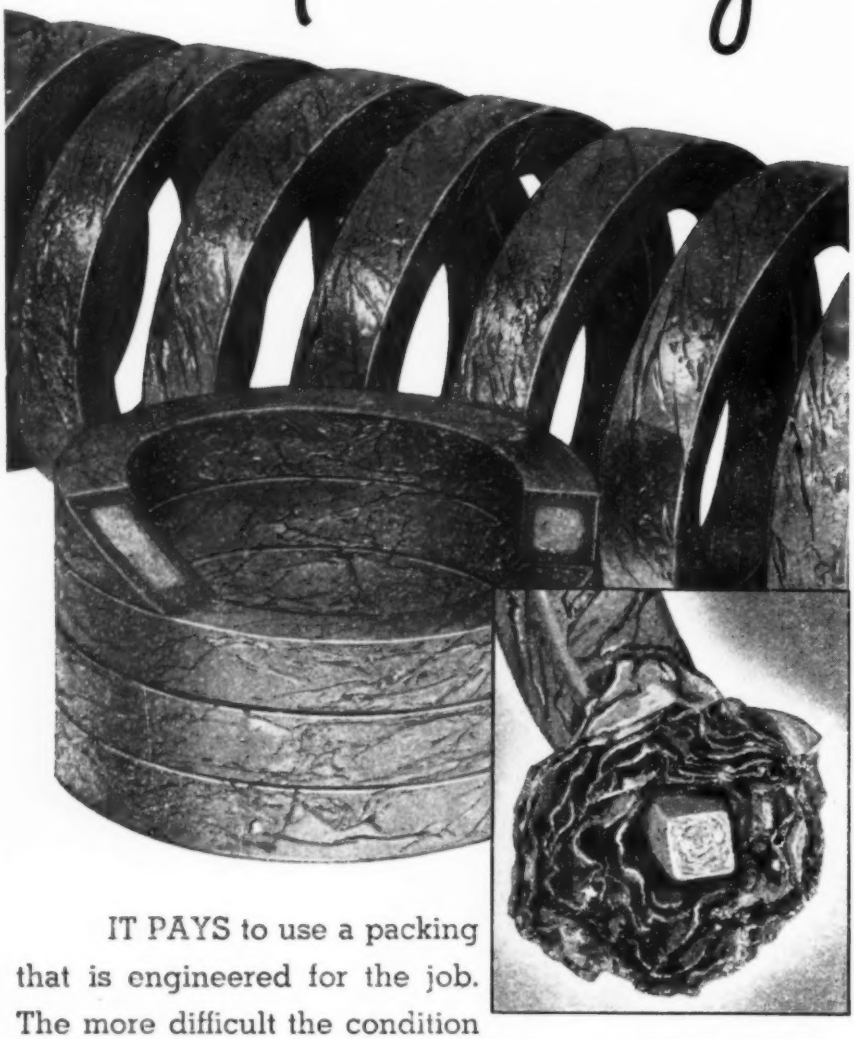
Established 1842

HOLLIDAY & SARATOGA STS., BALTIMORE-2, MD.

Representatives in Principal Cities

REPRESENTATIVES WANTED in Virginia and the Carolinas Attractive sales territories now open to aggressive individual or company. Contact manufacturer for details of franchise.

DURAMETALLIC Packings



IT PAYS to use a packing that is engineered for the job. The more difficult the condition the greater the chances are that you need DURAMETALLIC PACKINGS for effective sealing and long uninterrupted runs.

★

Write for Illustrated Bulletin and Free Engineering Counsel

The DURAMETALLIC "Twist"

- Processed to retain lubrication.
- Provides readier response to gland pressure.
- Distributes frictional load over several diagonally wrapped metallic sheets.

The PERFECT SEAL

DURAMETALLIC CORPORATION
KALAMAZOO MICHIGAN

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a new one. More than likely it has sprung sideways, a defect difficult to remedy without considerable loss of material and ring efficiency. Exercise extreme care when pulling the piston because if the rings jam they may be twisted and sprung.

Check wristpin and bushing next. Wristpins are of special high-grade steel, heat treated, ground and polished. They are secured by locked setscrews that fit into recesses in the pins. If wear is excessive, nothing can be done except to replace pins and bushings. Only a few adjustable wristpin assemblies are now in use.

Usually not more than two out of every ten suction valves will be found in satisfactory condition. To dismantle these valves, try using an 8x½-in. steel strap with two pins spaced to fit the small holes in the valve face, and with ⅜-in. holes to match opposite holes in the valve cage. Fig. 7. This device may be clamped in a vise and the valve bolted to it. Cotterpin can then be removed and the nut unscrewed without much difficulty; a snappy jar on the threaded end of the valve stem with the end of a 1-in. brass rod readily separates the assembly.

Test Spring Carefully

Important item here is the spring. Its correct tension must be ascertained mostly by trial because even new ones do not always have desirable tension. Spring tension must just lift the assembled valve stem (with collar, nut and cotterpin) off the seat when held in vertical position. If the valve can be closed with a slight upward sweep of the hand, correct balance is indicated. Lapping with a fine carborundum compound applied sparingly to seat and corresponding valve disk puts the valve in perfect condition. After grinding, wash the compound off with carbon tetrachloride or vandalin; then hold the entire valve assembly in an airblast for final cleaning. When all valves have been overhauled, apply clean oil to the ground surfaces as a precaution against oxidation.

Discharge valves and cages are easily removed from the false head in preparation for cleaning. The springs have a tendency to wear on outer periphery of the coil with an obvious weakening effect. If it is excessive the springs should be renewed. To facilitate grinding the valves, it is necessary to resort to a homemade guide because the valve cages, *B*, Fig. 8, are closed, or nearly closed, at the top, which prevents inserting a grinding tool. A spare cage,

(*Continued on page* 156)

SENT HOME...

BECAUSE OF A *Shoestring* Plant Power System

COULD IT HAPPEN IN YOUR PLANT TOMORROW MORNING?

● **The sudden flash—the stalled machines—the catcalls of idle operators—the hurried conference at the desk of the maintenance chief—**

● **Then, the inevitable layoff—FOR PLANT POWER-SYSTEM REPAIRS!**

Today, many otherwise well-equipped plants are "getting by on a shoestring" in transporting electric energy from the point of entrance to individual departments and machines. Weak spots in the system remain undisclosed, until suddenly something *snaps!* Then, repairs that take days to complete may be necessary.

If your plant power system has been adapted and extended to handle loads that it was not orginally designed to meet, it may now be partly or wholly a "shoestring" system: containing make-shift circuits; circuit breakers and fuses with inadequate interrupting capacity; long, overloaded feeders.

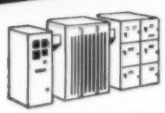
In addition to the outages you risk, such a system is often the overlooked cause of low production due to sluggish drives and poor lighting, and of high maintenance expense. Nurse it through for the time being if you must—but start planning now to replace it.

HERE'S *How* to plan for fully modern power distribution throughout your plant, using the G-E load-center system.

GENERAL ELECTRIC

BLOCKS of POWER*

right at each LOAD CENTER



*** BLOCKS OF POWER**

— — complete, compact, fully enclosed unit substations—are the basic elements of the G-E load-center distribution system for industrial plants.

In this system, plant power is distributed at high voltage to the substations, located at or near individual centers of power demand. Here it is transformed to a lower utilization voltage and distributed over short, individually protected feeder circuits.

Thus, you avoid the high costs and voltage drop that result from use of long, heavy low-voltage feeders from a single, remote substation. You have a fully co-ordinated system throughout.

The best investment in the world is in this country's future. Buy War Bonds

GENERAL ELECTRIC

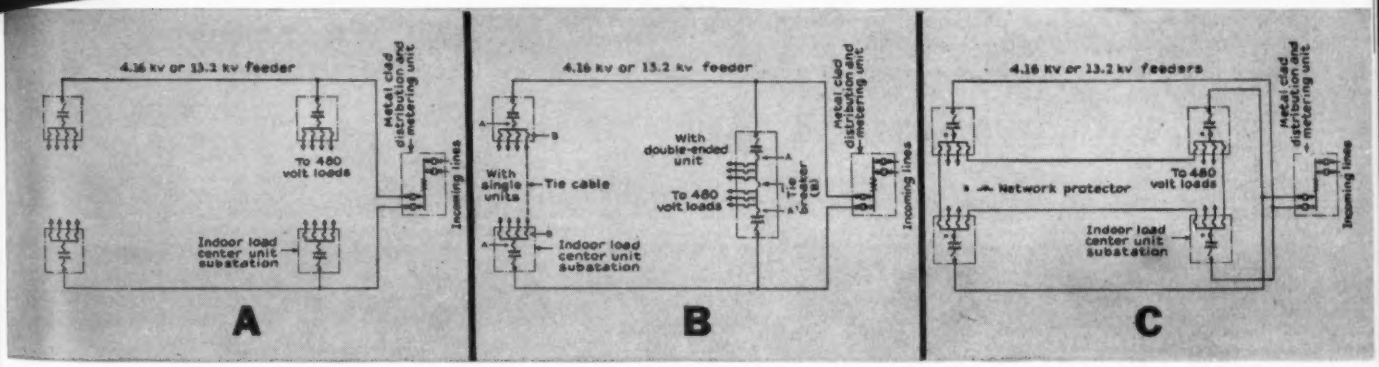
. . . safeguard your plant from CRIPPLING OUTAGES

The load-center distribution system—having G-E unit substations, and auxiliary equipment designed to tie-in with them—is the safe, modern way to guard against interruptions in power supply within your plant.

Even an inexpensive radial arrangement (see A below) is highly reliable when G-E unit substations are used, because the interrupting capacity of the switchgear is exactly matched with transformer capacity. *Self-protection* at each load center isolates most trouble within a single, short, low-voltage feeder circuit. And even when a primary circuit is opened at *one* substation, other load areas are not affected, and work can proceed as usual.

For still higher standards of service continuity, you can choose from a number of circuit arrangements such as the secondary selective (B) and the secondary network (C). The extra cost of this "service insurance" is far less than that of duplicate, long, low-voltage feeders from a single outdoor station.

Perhaps the biggest gain of all in avoiding power-system breakdowns comes from planning a co-ordinated system right from the start, using well-matched equipment of the proper capacity right where you want it. The load-center system permits you to make such a plan *now*, installing it complete, or block-by-block as a part of a gradual modernization project.



THE SIMPLE RADIAL arrangement consists of one or more load-center unit substations supplied by one primary feeder through one primary breaker. It is entirely adequate for the majority of installations. A radial circuit is low in cost and is extremely easy to operate. It offers a high degree of continuity when high-quality electric equipment is used throughout.

THE SECONDARY SELECTIVE arrangement uses duplicate primary feeders and transformers to supply each secondary load bus. Single-transformer unit substations are arranged in pairs (as shown at the left in the above diagram), or a double-transformer unit substation (as shown at the right) can be used.

THE SECONDARY NETWORK consists of two or more primary breakers and primary feeders, and two or more load-center unit substations, with the secondaries of the transformers operated in parallel through an inter-connecting grid. *Automatic* switching equipment disconnects a faulty transformer or primary feeder without any attention from an operator.

Get Started NOW for FUTURE PROTECTION
. . . Follow this Simple Plan

Plan Now for a *Fresh Start* in Plant Power Distribution

1 Begin with expected LOAD DENSITIES

Analyze today's power loads in terms of volt-amperes per square foot. Consider tomorrow's further electrification needs in each department.

2 Map out your LOAD-CENTER ZONES and FEEDERS

Subdivide floor areas in zones of 300 to 1000 kva, and determine the *service continuity* that each requires.

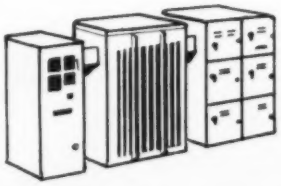
3 Work with G.E. on a "ONE-LINE DIAGRAM"

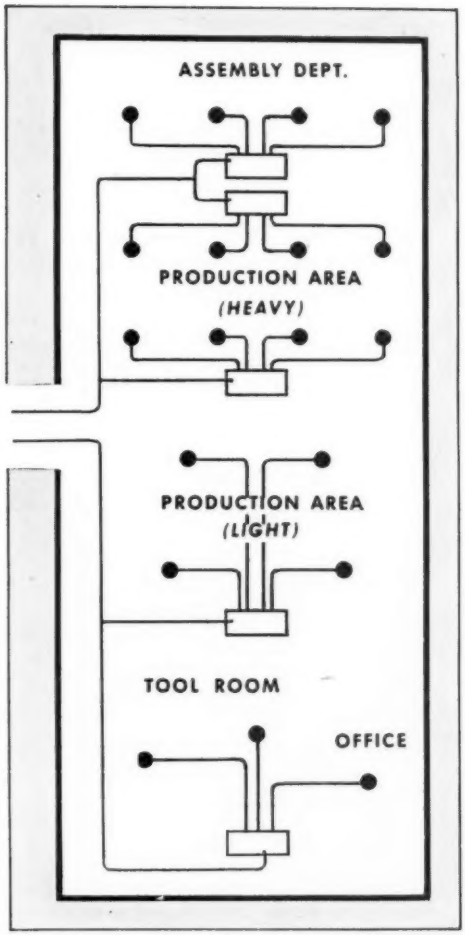
We'll sit down with you and your engineers to decide on the number and arrangement of unit substations, switchgear equipments, etc., and the interconnecting circuits you will ultimately want for a completely modern system.

4 Be ready to order STANDARD EQUIPMENT

G-E load-center power distribution equipment is built up by block-assembly from standard, repetitively-built designs. Once your "one-line diagram" is complete, you can begin modernizing step by step at your necessity or convenience, using well-matched standard equipment.

For further information on G-E unit substations as applied in load-center distribution systems, write for Bulletin GED-1006. *General Electric Company, Schenectady, N. Y.*





LOAD-CENTER POWER DISTRIBUTION SYSTEM

GENERAL ELECTRIC

302-28-5900

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THE 3 BIG ADVANTAGES OF QUALITY LEATHER and 3 EXCLUSIVE FEATURES OF "RESEARCH" BELTING

MORE PRODUCTION, because leather's superior traction improves with age, means more power delivered . . . greater average machine production.

LESS MAINTENANCE, because leather has natural "give and take" to handle shock loads without undue strain on belt or equipment.

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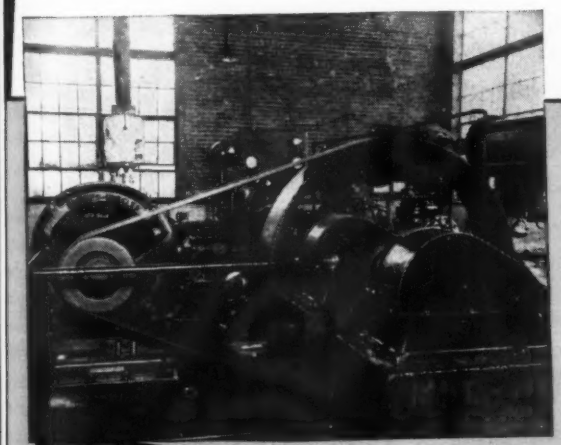
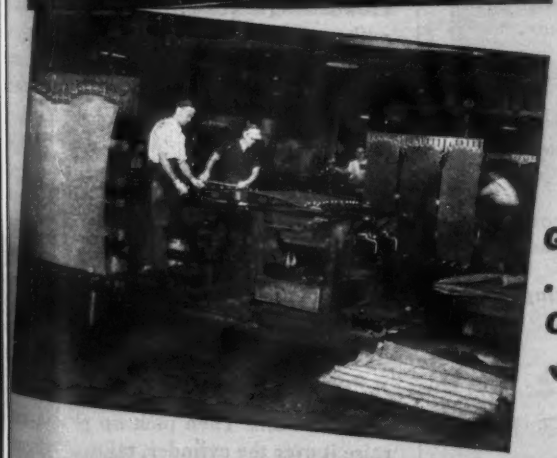
MOST PRODUCTION, because "Research" currying added to leather's superior traction creates highest frictional surface. 3% more production guaranteed.

LEAST MAINTENANCE, because G&K'S pre-stretching process removes non-elastic stretch, resulting in fewer take-ups. Tensile strength is also increased 15%.

LONGEST LIFE, because precise weight-controlled lubrication of fibres develops extremely long life. "Tension-Cementing" insures against ply separation.





HERE'S A TYPICAL EXAMPLE OF

LEAST MAINTENANCE

WITH "RESEARCH" ON YOUR DRIVES

These "Research" Belts, installed June 1940, have required no maintenance — not even shortening. Drive data: 100 KVA synchronous motor, 900 R.P.M. — mounted on No. 14-I Rockwood pivoted motor base . . . 17½" diameter motor pulley . . , 72" compressor pulley . . . 78" center distance . . . bottom pull . . . 14" G&K Research Double, 25½' long. 12" motor pulley, belted by 4" G&K Research Double, 10' 11" long, drives exciter with 7½" pulley mounted on No. 6 Rockwood base . . . 50" center distance.

"Research" Belts come to you pre-stretched to save you the trouble and cost of frequent take-ups. Pre-stretching by an exclusive method — according to hide characteristics.

GET AT LEAST 3% MORE PRODUCTION ...2 TO 4 TIMES LONGER LIFE ON LONG OR SHORT CENTERS...by specifying "Research" the Belt with the

Graton & Knight is the only leather belting manufacturer with complete nation-wide service facilities. Branches in Chicago, Cleveland, Dallas, Detroit, Kansas City, Minneapolis, New York, Philadelphia, St. Louis, San Francisco; distributors in all industrial centers.

Look under "Graton & Knight" in Belting section of Classified Telephone Directory or THOMAS' REGISTER.

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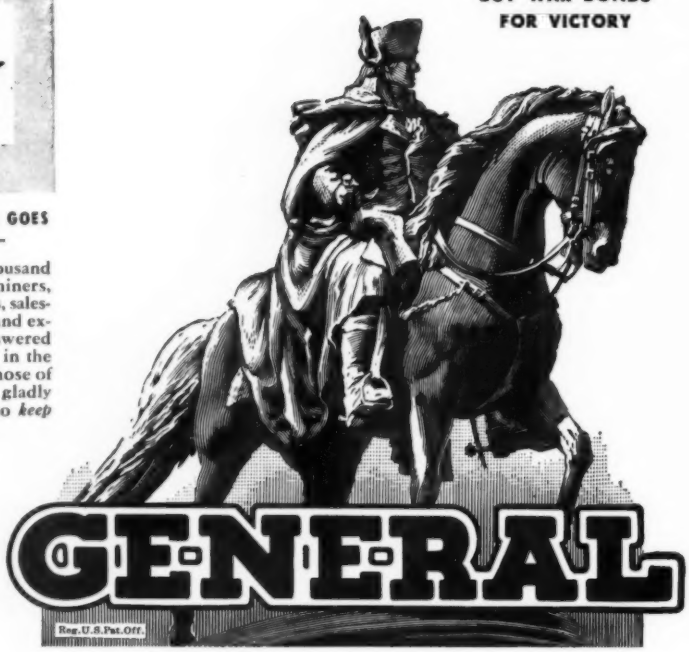
GENERAL COAL GOES TO WAR—

More than a thousand of our men—miners, machinists, clerks, salesmen, engineers and executives have answered the call to serve in the armed forces. Those of us left behind gladly "Close Ranks" to *keep the coal rolling.*

BUY WAR BONDS FOR VICTORY



GENERAL

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RODA — High grade gas, by-product and steam coal from Wise County, Va., on the Interstate Railroad.

DENDRON — High grade gas, by-product, steam and domestic coal from Wise County, Va., on the Interstate Railroad.

STONEGA — High grade, high volatile steam and by-product coal from Wise County, Va., on the Interstate Railroad.

PREMIX STOKER — A laboratory controlled product blended to meet exacting stoker requirements. From Wise County, Va., on the Interstate Railroad.

COKE — Roda and Stonega from Wise County, Va., and Connellsville Coke from Pennsylvania.

CRITERION COAL — High grade gas, by-product, steam and domestic coal—Pittsburgh seam from Irwin Basin, Westmoreland County, Pennsylvania, on the Penna. Railroad.

CROZER — Genuine Third Vein Pocahontas from McDowell County, W. Va., on the Norfolk & Western Railroad.

Admiralty Coal — Genuine New River Smokeless, Beckley or Sewell seam from Raleigh County, W. Va., C. & O. and Virginian Railroads.

Old Kentucky — Hazard No. 4 and No. 7 steam and domestic coal from Wiscoal, Knott County, Kentucky, on the L. & N. Railroad.

GENCO — Steam and domestic coals from a number of producing districts.

ANTHRACITE—Hazle Brook Premium . . . Raven Run

Our personnel with the experience gained through long and varied marketing activity assures proper application of one of the above brands and effective servicing of any fuel requirement.

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CINCINNATI DETROIT NEW YORK NORFOLK PITTSBURGH

A, however, may be drilled out to serve as a guide. Manufacturers number all parts of the assembly to guard against their interchange. A word of caution when bolting valve assemblies into place: Perform the operation with greater emphasis on even pull rather than on exerted force. The 3/8-in. studs break like glass if distorted in the slightest degree.

With all valves now in perfect shape and reassembled in the false head, ground edge on the head itself should be lapped to its seat on the cylinder with grinding compound until a perfect ground joint results, Fig. 9. Take special care to remove all grinding compound after lapping is finished.

Wash the entire interior of compressor with cleaning fluid and use compressed air to blow out last traces of foreign matter. Then apply coat of oil to cylinder walls. Also clean the suction and oil filters (screen type); cotton cloth units require new pads.

The oil pump, usually a rotary gear unit, is an important accessory and should be removed from the inclosure at the end of the crankshaft. Wear of the gear shaft is immediately apparent even before the pump itself is disassembled. Have a machinist replace the shaft or other worn parts while the compressor is being reassembled.

Small Things Count

There is one apparently insignificant item that should not be overlooked; connecting-rod bolt threads should be cleared if damaged so that the nuts spin on them freely. It is difficult and inconvenient for one hand to struggle with hard riding nuts while holding a heavy bearing cap with the other hand in a crowded crankcase. While wrestling with a tight nut you may, without discovering it, lift the bolt dowel pin out of its hole. The pin will be flattened by a comparatively light pull and, of course, will not enter its hole until it is repaired. If the trouble is not discovered the pin is pulled down flat until the nut appears to be tight, but obviously the bolt head is bearing on only one point and bearing trouble will surely develop.

Preparatory to reassembly turn the crank to its upper dead center. Place the ring-guide collar on the top edge of the cylinder and apply oil to it and the cylinder walls. Then pick up piston and raise it over the cylinder, taking extreme care that it does not bump against any part of the compressor. When clear of the top edge of compressor make certain that marked side of connecting rod is in front and insert the connecting rod bolts in their proper sockets. Leave the nuts in their proper location (fore and

FOR

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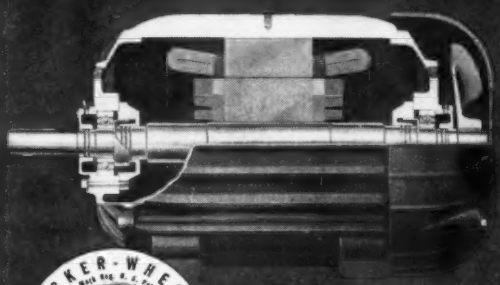
Flour Mills



CROCKER-WHEELER Motors-Generators

SEALEDPOWER
(Cowl-cooled) . . . available for all polyphase alternating current circuits, 2 to 15 horsepower. Write for detailed literature, or call our nearest office.

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Now a Corrosion-Resistant *SEALEDPOWER* Motor

PROTECTED AGAINST: acid fumes, alkali fumes, splashing or dripping corrosive liquids, air-borne moisture, steam, corrosive gases, conducting dusts, metallic chips, etc.

PROTECTED BY: a corrosion-resistant frame, cooled by a built-in corrosion-resistant fan. The windings are *doubly* protected from damage by Crocker-Wheeler's vacuum-impregnation process which seals *each* coil individually against moisture, fumes or dirt.

BRUTALLY TESTED! The seal's effectiveness is proved by laboratory tests (at right) and by hundreds of satisfactory installations.

1 **SEALEDPOWER** motor was placed in tank containing several inches of water and run continuously for 8 hours (see photo). It stood idle in water overnight, then was run 8 more hours. During motor's operation, the external ventilating fan drenched the outside of the frame with water. At end of test, the motor was disassembled and found to be *completely dry* inside.

2 A dense atmosphere of extremely fine French chalk was kept circulating around the motor and through its ventilating system for many hours. No trace of chalk was found inside upon disassembly.

JOSHUA HENDY IRON WORKS

CROCKER-WHEELER DIVISION

ESTABLISHED 1856

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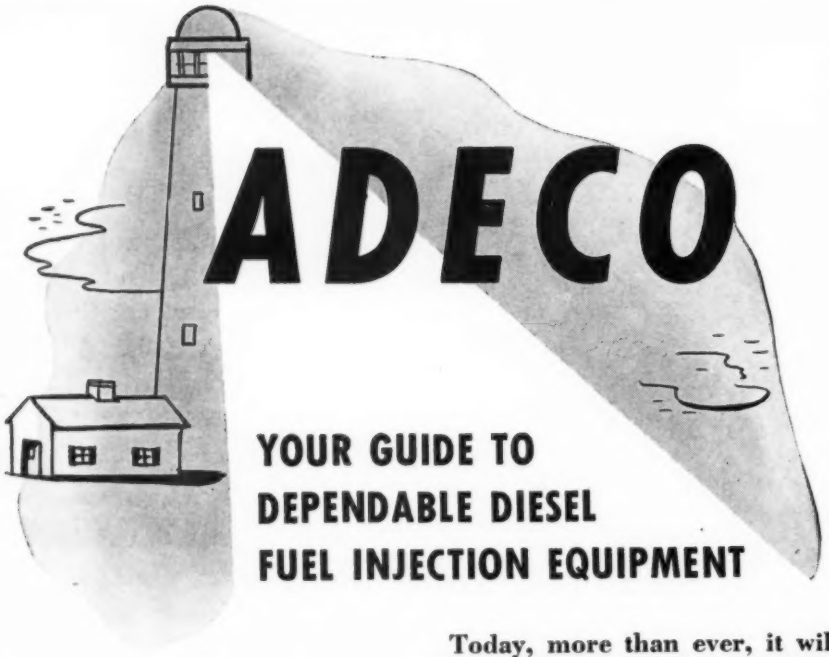
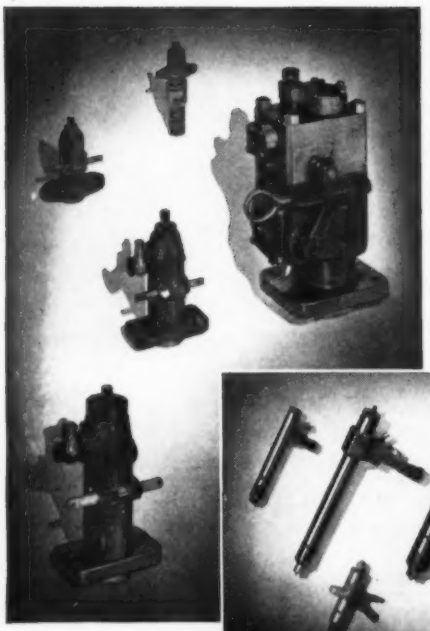
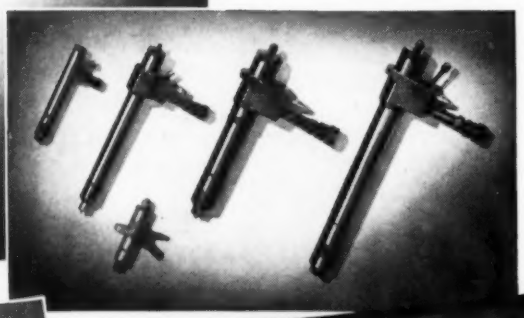


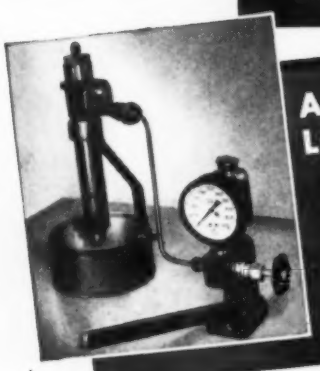
Today, more than ever, it will pay you to look to Adeco as your guide to dependable fuel injection equipment.

Every Adeco fuel injection pump, nozzle and nozzle holder reflects the long experience in precision design and workmanship gained through years of pioneering and research for the diesel industry.

There's a wide range of standard equipment to meet your most exacting needs.







ADECO NOZZLE TESTER FOR LOW-COST MAINTENANCE

America's most widely used Nozzle Tester enables any mechanic to make quick, accurate tests on injector opening pressure, spray pattern, etc., and detect stuck needle valves and leakage around valve seats. Compact, portable, sturdy, precision-built. Pressure up to 10,000 p.s.i. Tests both large and small injectors. Avoids costly delays and possible damage to engine. Also obtainable with Navy-approved gauge. Write for new bulletin.

Ideal for Testing Hydraulic Equipment

ADECO

AIRCRAFT & DIESEL EQUIPMENT CORPORATION
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aft) in the compressor crankcase.

Lower piston enough to bring the rings within convenient reach, stagger the joints but position the open ends so that they are as far away as possible from the large suction opening in the cylinder. Apply a liberal quantity of oil before lowering piston into cylinder. See that piston moves with every click of the chain hoist because if allowed to go slack, the loop will unhook easily and the piston go down with a crash at the slightest touch.

Even if provisions are made to prevent unhooking, a sudden drop from one ring to the other (if the chain is slack) will invariably damage the ring. Frequently it is necessary, especially if the piston is lowered at a slight angle, to help the rings into the cylinder with a soft metal pry-bar, even though the collar has compressed them to the proper dimension for entering the cylinder. Chain fall must take the weight at all times or damage will result.

When the connecting rod is lowered to within about ¾ in. of crank (in upper dead center) insert the top half of babbit bearing so that punchmarks show forward. The bearing-half is given a good dash of oil evenly spread over its entire surface, pushed against the bottom of the crank and slid around to the top. It is not possible to slide this half into place if the crank is not in absolute dead center. Slight cranking by an assistant one way or the other may be necessary.

Watch Bearing Closely

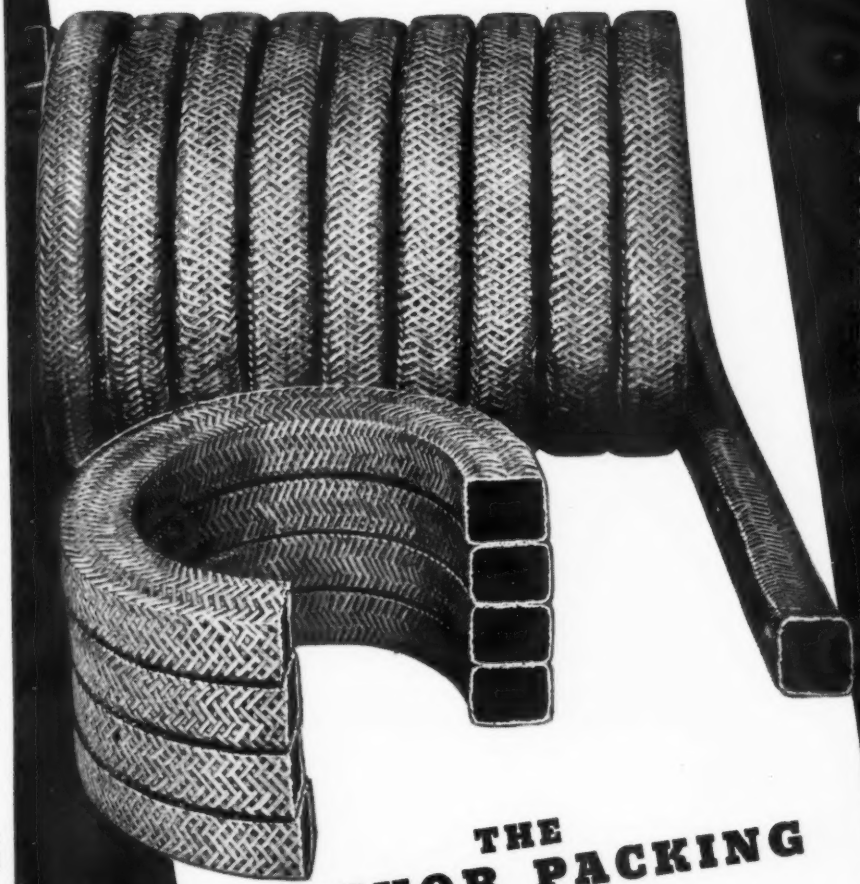
It is imperative, however, to hold the bearing, or it will quickly slide around from a jammed position, fall and break. With bearing in proper position, lower piston until the crank seats and chain is slightly slack. Then oil the bottom half in its cap, remove the shim holding wires and raise the cap into place with stamp and punchmark forward. The nuts, now handy in the crankcase in their proper location, can be applied without further trouble. Draw bearing up just tight enough to be well seated.

After unhooking this piston swing the rigging into position over the next cylinder, put ring-guide collar in the other cylinder and turn its crank to upper dead center in preparation for entering the next piston.

With both pistons in place install the suction valves, putting all valves into their openings before handling any cap-screws and lockwashers. When securing the valves, remember that tension on opposite screws at moderate force results in a better and safer job than does unequalized tension at extreme force. A screw drawn up too tight, even if the

ANKORITE
No 858 CWB . . .

A Good Number to Remember



WHEN PACKING TROUBLES OCCUR

PLASTIC CORE COPPER BRAID No. 858-CWB

A plastic core packing made from lubricated long fiber asbestos graphite mixture containing soft metal particles and encased in a copper jacket. This style of packing is useful on rods and plungers operating against steam, hot oil, or for high temperature valve stems and expansion joints. It may be used alone or in combination. Spirals are 10 feet in length. Sizes ¼" to 1¼".

RECOMMENDED USES:

Steam
•
Air
•
Expansion Joints
•
Valve Stems, Etc.
Rotary and Reciprocating
•
750° F
Pressures to 1500 PSI
•
A Good Packing
for
Hydrofluoric Acid

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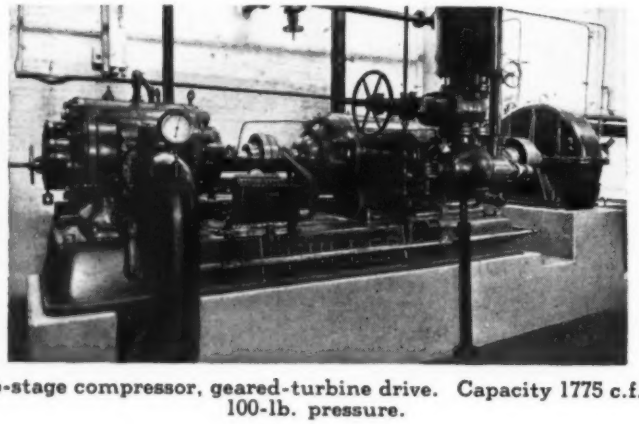
THE ANCHOR PACKING CO. TRADE A MARK

FULLER
ROTARY COMPRESSORS
for
ECONOMICAL AIR AND GAS COMPRESSION



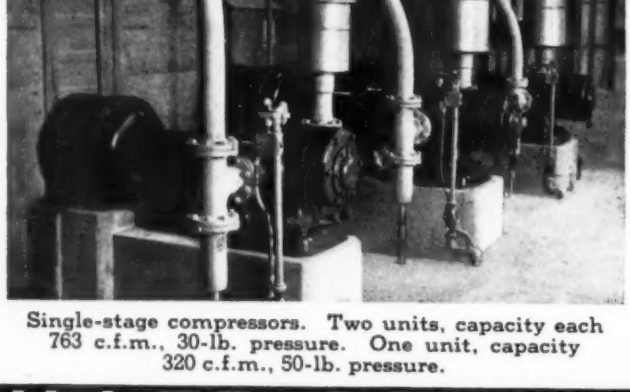
Two-stage compressor, geared-turbine drive. Capacity 1775 c.f.m., 100-lb. pressure.

For many years Fuller engineers have striven to build the best compressor money could buy . . . simple in design, rugged construction for long, continuous service at minimum operating expense.

Performance records show they're truly the economical unit . . . in a foundry $3.90 for repairs in three years; in a patent fastener plant after four years' operation: "It has run 23 hours per day almost continuously and has given no trouble." Not a cent was spent for repairs during this time. A plant engineer in a war industry writes: "It is now approaching the third year of continuous operation for your two-stage compressor, during which time we are glad to report that the service-load factor has been in the neighborhood of 99.9 per cent."

Fullers are built for capacities to 1800 c.f.m. actual free-air delivery, 125-lb. pressure.

Write for Bulletin C-5, illustrating and describing these machines.



Single-stage compressors. Two units, capacity each 763 c.f.m., 30-lb. pressure. One unit, capacity 320 c.f.m., 50-lb. pressure.

C-90

FULLER COMPANY
CATASAUQUA—PENNSYLVANIA
CHICAGO Marquette Bldg. WASHINGTON, D.C. Colorado Bldg. SAN FRANCISCO Chancery Bldg.

thread is not damaged, will break off at the head during operation and do untold damage.

Safety head, springs and outer heads can now be replaced and the top of the compressor closed up. Replace all small covers on the machine, giving due attention to gaskets which may need replacing. Insert suction-strainer screen and close up. Only the oil filter, if it is of the newer type, is left open; floor type is filled with oil and closed up.

Final adjustment of crank bearings requires careful attention. Usual procedure is to remove light shims until the shaft just binds, then insert shims to provide desired bearing clearance and draw the bolts up tight. For a 6-in. crank 0.005 to 0.006-in. clearance gives good results. After the clamping nuts have been secured with cotterpins and setscrews, give the crankcase a final thorough cleaning, fill it with clean oil to the required level, and close it.

After the oil pump is repaired return it to place using new gaskets as required. And last, if a cotton pad, or the newer filter, is used, fill its container with oil, insert a new filtering unit, and close up.

Don't Forget Valves

Routine schedule calls for removing all manifold valves for inspection and eventual renewal of disks and valve stem packing. Crankshaft packing is usually good for many years; however, if it appears badly worn renew it before putting the machine into service again. When inserting semi-metallic packing be careful to put the first ring into the stuffing box with its rounded, flanged lead surface against the inner metallic ring. If the opposite side is put in first the lead may travel into the crankshaft bearing, from which it cannot be removed without tearing the machine down and removing entire crankshaft.

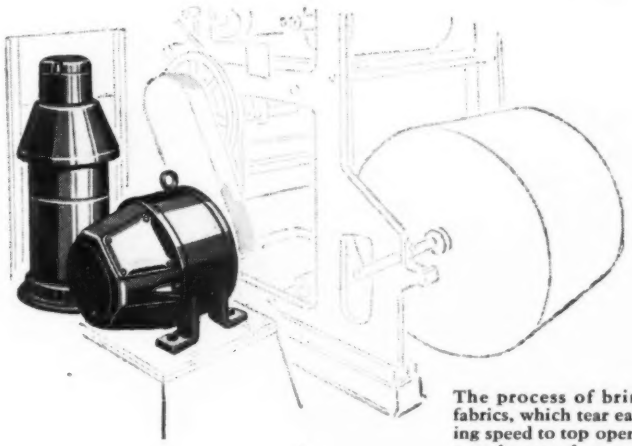
After turning over by hand to see that everything is free, the compressor is ready to be pumped out. With all manifold valves closed, open wide the valve in compressor head; open small crankcase pumpout valve one or two turns and start the machine. Within a few minutes it will pump a vacuum in the crankcase, as indicated on the oil gage. Slowly open wide the h-p side pumpout valve and suction valve, both on the manifold, to pump out the high- and low-side pipe connection. As soon as the highest possible vacuum is obtained, probably between 27 and 29 in., stop the machine and quickly close the valve in compressor head, but not entirely until the machine has completely stopped. Valve opening may be covered with the hand to prevent air leaking in until the

SMOOTH!

Smooth starts, *smooth* acceleration and deceleration, and *smooth* speed changes—all without clutches or brakes—are important characteristics of electric motor-drive. That they can be made to contribute substantially to improved production rates, quality and lower costs has been shown repeatedly by Reliance engineers.

Through pioneering work in many industries, Reliance men have demonstrated that motor-drive, properly applied, can be *more than power*—that, in itself, it can provide for the performance of a wide variety of operations, all with maximum simplicity, efficiency and *smoothness.*

If you would like to invite a Reliance man to come in and talk things over with your own engineers and production planners, please let us know.



The process of bringing foils and sheer fabrics, which tear easily, from low threading speed to top operating speed furnishes a real test of smooth acceleration. This is met successfully by the Reliance V★S Adjustable-speed Drive for A-c Circuits.

RELIANCE A·C D·C MOTORS

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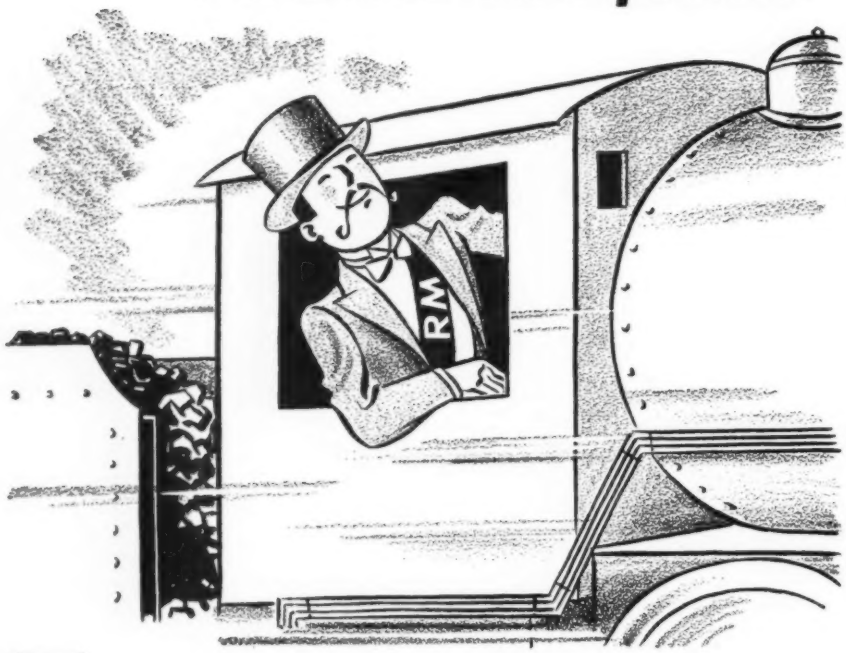
R/M PACKINGS
throttle the joints



Today's locomotives are typical users of R/M packings. Steam connections, valves, pistons, air-brakes are some of the spots where R/M serves to speed supplies—when extra wearability means many more miles of service.

Railroads and other vital industries must have first call on R/M production in time of war, but we will continue to try to serve your requirements through your regular mill-supply house.

ARMY E NAVY

INDUSTRIAL SALES DIVISION
RAYBESTOS-MANHATTAN, INC.
MANHEIM, PA.
BRIDGEPORT, CONN. NORTH CHARLESTON, S. C. PASSAIC, N. J.
Makers of Packings for Every Industrial Use

valve can be fully closed. Now close manifold valves and open the overhead system valves with caution. Pressure may then be applied to the compressor by opening the pumpout valve on manifold slightly. If no leak is apparent, close pumpout valve and relieve the pressure through the bypass.

A short test run on the line soon reveals the compressor's revived capacity. At any rate, amount of care and degree of conscientious attention to the numerous details of a thorough overhauling is reflected in better performance.

Readers' Problems

(*Continued from page* 112)

satisfactory only with a low outside wet-bulb temperature and small latent-heat load in the control room. Here again increasing the quantity of air supplied would be advisable. Ten air changes per hour, or 12,000 cfm, would not seem too great a quantity for such an installation.

Of course, if 15 air changes per hour, or 18,000 cfm, does not appear too great a rate of change, a 90 F db temperature could be maintained without any refrigeration, with outside temperature 80 F.

New York, N. Y. MAURICE MARTIN

Ventilating Hoods Carry Off Heat

BASED ON TEMPERATURE INCREASE of the ventilating air now circulated, HF must dispose of a heat gain of approximately 190,000 Btu per hr which is equivalent to 56 kwh of electrical energy, or 15 tons of refrigeration.

A water jet can be used to produce the required vacuum on an air-conditioning unit but cannot be used in place of steam in the same jets. A water jet would be of considerable size and its cost would probably prohibit its use.

If the heat-liberating elements in the room were arranged in systematic order it might be economically possible to build exhaust hoods over or around them and connect these hoods to an exhaust duct to carry off the heated air before it became diffused through the room. Such an arrangement should greatly improve room temperature, even though the present ventilating fans were used on this exhaust duct.

Such an arrangement concentrates the heat-removing capacity of the ventilating system over the heating sources with consequent higher exhaust temperatures and lower room temperatures.

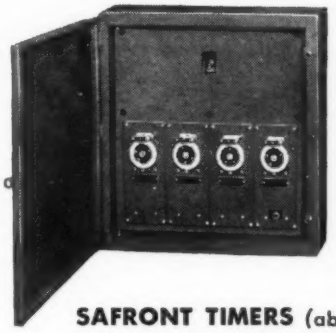
Columbus, Ohio I A BUTCHER

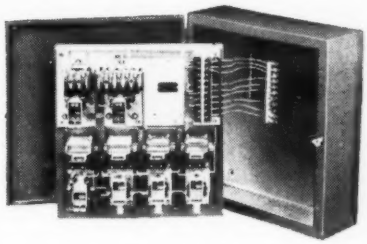
(*Continued on page* 164)

MORE PRODUCTION WITH LESS OPERATOR SKILL *when resistance welders have* SQUARE D *Automatic* CONTROL

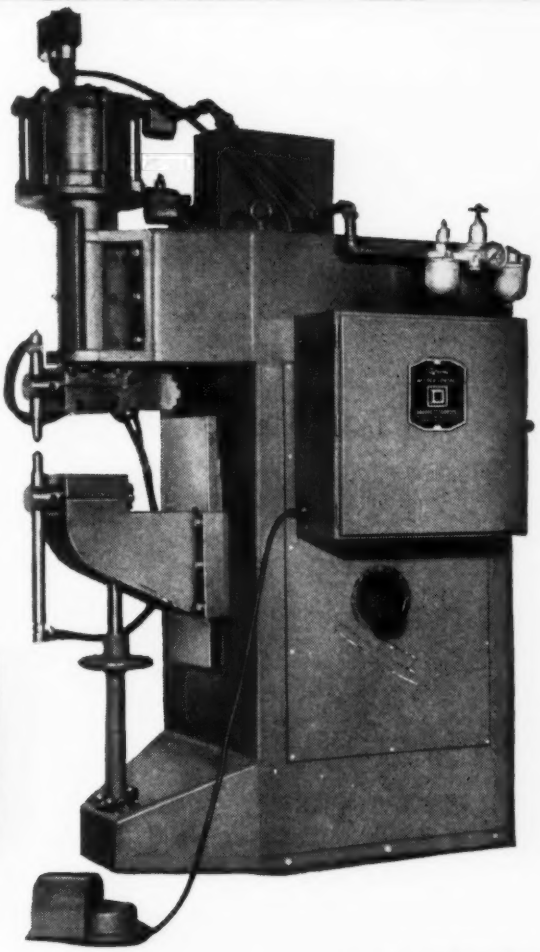
● Consistently good resistance welding at high production rates requires automatic control of pressure and current in an accurately regulated sequence. Square D welder control meets those requirements—exactly. It is simply designed, easy to install and maintain. With Square D automatic control on the job, very little operator skill is required—a vital angle during today's scarcity of skilled manpower.

Specify Safront timers and Syncro-Break or High Speed contactors on new welding machines. Or, if increased quality and production is needed from present machines, find out how easily they can be equipped with automatic control. Consult your nearest Square D Field Engineer.

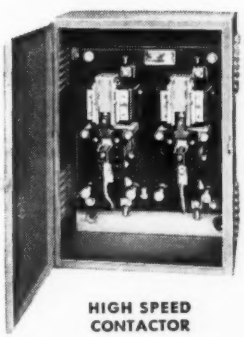




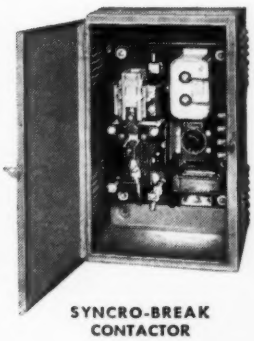
SAFRONT TIMERS (above) are built in 18 NEMA standard types. Notice, in upper left photo, how all electrically energized parts are behind a protective panel, yet calibrated timer adjustments are accessible on panel front. Separate timing devices, provided for each step of the welding cycle, are individually adjustable from 3 to 100 cycles. Safront interiors "swing out" (upper right photo) to expose operating parts.



HIGH SPEED AND SYNCRO-BREAK CONTACTORS (right) possess unusual design features necessary for frequent making and breaking of the welding transformer primary circuit. The Syncro-Break design includes means for opening circuit without arcing at contact tips, thus increasing contact life and allowable ratings.



HIGH SPEED CONTACTOR



SYNCRO-BREAK CONTACTOR

ELECTRICAL EQUIPMENT • KOLLSMAN AIRCRAFT INSTRUMENTS

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

At installation the orifice is adjusted until correct operation is indicated in the gauge glass.

Thereafter, the trap operates at high efficiency under widely varying volume of condensate and air.

Having none of the moving parts of conventional traps that corrode, wear, stick and leak its efficiency remains unvarying for long periods.

This unusual performance and freedom from annual maintenance and repairs gives unprecedented results at the lowest cost yet attained.

Model M-41-S Drainator

TYPE M-41-S is smaller and lower priced than the standard 1/2" Drainator but with adequate capacity to handle a large percentage of loads usually put on this size of trap with typical Drainator efficiency. The magnetic operation indicator can be installed on either side.

The COE MANUFACTURING Co.
501 BANK ST., PAINESVILLE, OHIO

DRAINATOR• THE ADVANCED STEAM TRAP

Write for a copy of Bulletin No. 903-A or ask us to send an engineer to discuss your condensate handling problems.

Increase Air Circulation

IN ANALYZING THE DATA presented by HF, it appears that heat load in the room, consisting of resistors and lamps and neglecting transmission through walls, can be computed as follows:

Air circulated = 5 changes per hr, or 1 change every 12 min. Therefore,

$$\frac{\text{room volume}}{\text{time for one change}} = \text{cu ft per min.}$$

$$\text{or } \frac{60 \times 100 \times 12}{12} = 6000 \text{ cfm}$$

$$\text{Btu per hr} = \frac{\text{cfm circulated}}{56} \times \text{temp rise} \times 60 \text{ min}$$

where

1 Btu = 56 cu ft air raised 1 F

$$\text{or } \frac{6000}{56} \times (110 - 80 \text{ deg}) \times 60 =$$

193,500 Btu/hr

Simplest solution is to increase the quantity of air circulated. Increasing the circulation to 18,000 cfm would reduce the temperature rise to 10 deg, giving 90 F room temperature. The air change would now be 1 every 4 min, which is not excessive. HF should consider installing air filters. All of the air should be vented in summer. As the outside temperature drops, he can reduce the number of air changes, and in winter recirculate a large portion of the air.

Detroit, Mich. L SEELIG

Answers to Feb Question 2

(*Continued from page* 116)

the system is small and it is impracticable to keep the needle valve cracked, have the operator blow the line out every few hours.

Brooklyn, N. Y. A J WENIG

Alcohol Is Dangerous

ALCOHOL, EITHER ETHYL OR METHYL, is highly explosive when mixed with the right amount of air, and should under no circumstances be used in a compressed-air receiver to prevent freezing of the drain.

A mixture of air and alcohol containing as little as 4% ethyl alcohol by volume is inflammable, while the top limit is approximately 19% at ordinary temperatures and pressures.

Methyl alcohol requires almost 6.5 lb of air per lb of alcohol for complete combustion while ethyl alcohol requires about 9 lb of air. Heat values of various alcohols vary but are on the order of 10,000 Btu per lb.

Inclosing the air receiver to protect it from freezing is the safest procedure.

Columbus, Ohio I A BUTCHER

Putting the *heat* on the axis . . .

America's great production power is putting the heat on the axis. This has been achieved by the efficient manufacture of various parts in hundreds of widespread plants and then assembly of the finished war weapon in main plants. In the same way, Benjamin F. Shaw Co. is serving war industry by efficiently pre-fabricating piping in a series of sub-assemblies which are delivered to job ready for quick installations. Look to Shaw now for today's piping needs and for recommendations on post-war planning.

Benj. F. Shaw III
President

Like Pre-fabricated Tanks and Planes

PRE-FABRICATED PIPING

Is Necessary To Win The War

BENJAMIN F. SHAW COMPANY

2nd & Lombard Streets Wilmington, Delaware

For Personal Security - for National Security - Buy War Bonds

SLOW DOWNS
in your Cooling Water System

Slime growths in your condenser water seriously lower production by cutting down power—and by actual loss of working hours if you have to take "time out" for a mechanical cleaning job. Often a shutdown for cleaning cannot even be considered.

Even thin slime deposits may reduce heat transfer as much as twenty-five per cent., and cost needless extra tons of fuel.

The Wallace & Tiernan Intermittent Desliming Process will keep your condenser tubes clean at all times, and keep the unit on the line continuously, maintaining vacuums at or above the manufacturer's guarantee.

Wallace & Tiernan Engineers will gladly give you the benefit of the experience they have gained in eliminating severe sliming conditions in many hundreds of industrial plants.

Why not let them make recommendations to meet your individual problem?

CD-5-C

WALLACE & TIERNAN
PRODUCTS · INC.
Manufacturers of Chlorine and Ammonia Control Apparatus
Belleville 9, New Jersey • Represented in Principal Cities

Argument Corner

(*Continued from page* 124)

tion traps in the steam connection. The fourth point is to avoid making the water connections at any place where a false level could be set up in the expansion tube.

Erie, Pa. L D CARLYON
Northern Equipment Co

Moisture in Compressed Air

WITH THE ARRANGEMENT in PMG's question (Oct, 1943, POWER) some moisture is bound to collect in the low main in the pipe tunnel as there is no provision for removing water. Only excessive accumulations will be blown out by the air stream during periods of heavy use.

Here are several possible remedies:

(a) Most satisfactory way to prevent difficulty is to remove moisture immediately after compression with suitable aftercoolers. Although his system contains such a cooler he should check it against the conditions to which air distribution is subjected. Air from the aftercooler should be about 3F lower than lowest temperature in the east building. Air temperature from the aftercooler can be checked by bonding the bulb of a pencil thermometer to the pipe with white lead at a point protected from room air currents. If temperature is too high, use a larger aftercooler or colder cooling water.

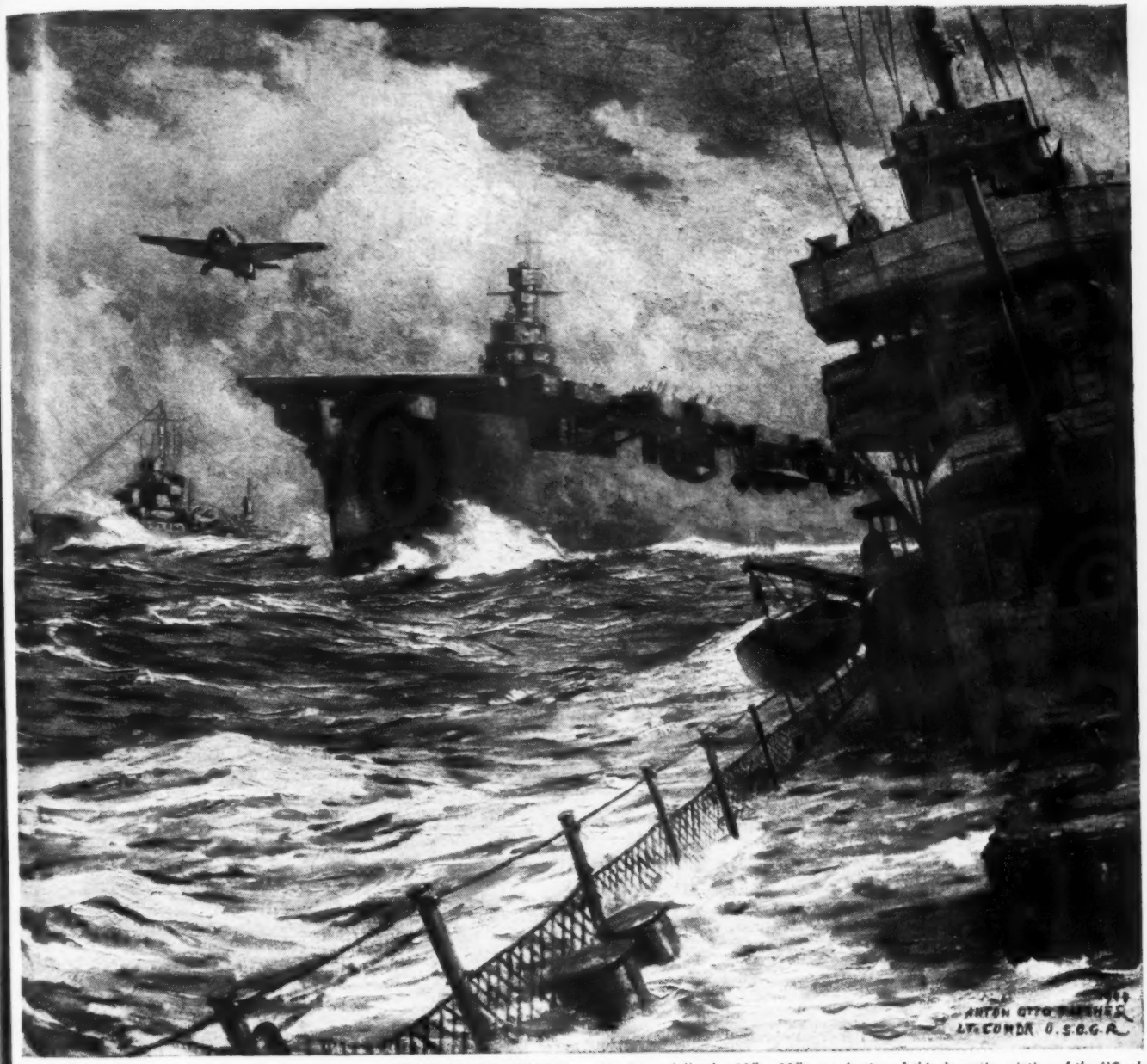
(b) If the aftercooler air discharge temperature is found adequate, check the compressor water jacket and aftercooler for water leakage.

(c) In any case, I recommend installing a water separator on the end of the 7-in. main in the tunnel, as recommended by manufacturers of such equipment, with the main pitched down towards it.

(d) Pitch the east main away from the pipe tunnel. If practicable, the main should be designed for a high degree of moisture separation; that is, make reduction in pipe sizes with eccentric reducers installed with their straight sides at bottom, and with no branch takeoffs facing the air flow, where main piping changes direction of travel. A simple water separator and blowoff should then be rigged up at the end of the main.

(e) Check compressor air intakes and arrange them so that no rain water will enter.

(f) East main and tunnel line may



AVAILABLE ON REQUEST . . . Handsome full-color 10" x 10" reproduction of this dramatic painting of the "Card Gang" by Lt. Commander Anton Otto Fischer, the internationally famous marine painter. No advertising matter.

The Card Gang . . . Scourge of the U-boats

A squat baby flat top with an unarmored hull . . . three over-age destroyers, class of 1917 . . . that's the famous "Card Gang" that helped clear the U-boats from the North Atlantic last year. Certainly not a formidable looking unit, this . . . but what it lacked in looks it made up in skill and daring . . . when it went into action it hit the enemy with everything but the anchor!

Strafing and bombing the Nazi-underseas craft the Card's aircraft squadrons, aided by the destroyers, earned a Presidential Unit Citation for destroying more submarines than any other team in Naval history. In one three-day battle this Task Unit sank or probably sank six submarines; damaged two others.

The "Card Gang" was in plenty of tight spots . . . lost one escorting destroyer in a terrific encounter with a U-boat pack during which a giant Nazi-undersea maurauder was rammed and attacked with bombs, depth charges, machine gun bursts, shell fire, and even shotguns and pistols before it was sunk. But the "Card Gang" won . . . saved all but 27 of the destroyer's crew. Men and women of the Star Electric Motor Company take a special interest in the continued exploits of the Card for three large motor generators of our manufacture are part of its equipment.

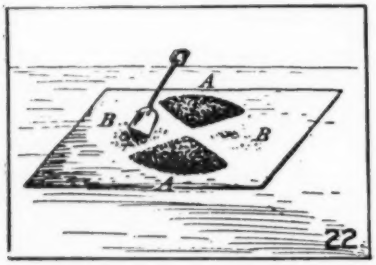
STAR ELECTRIC MOTOR COMPANY, Bloomfield, N. J.

STAR
MOTORS

POWER PACKAGED
AS YOU NEED IT

Is MANPOWER SHORTAGE *a problem?*

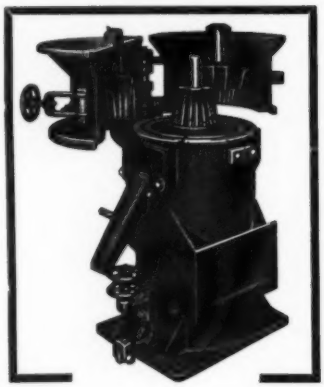
Here's just one of **34 HAND OPERATIONS** *eliminated by the*



STURTEVANT AUTOMATIC COAL CRUSHER and SAMPLER

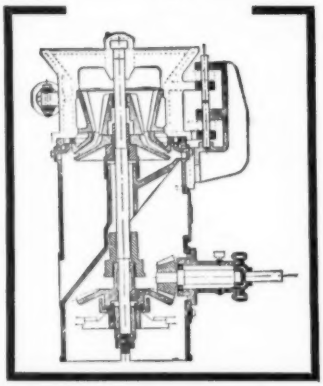
Why use manpower, already short, for inaccurate, inefficient, unsatisfactory hand sampling of coal when you can use machine power the "STURTEVANT WAY" and save men, effort, time and money and get truly accurate results?

Coal sampling by the old-fashioned hand method of shoveling, hand-crushing, mixing, quartering, piling and rolling not only involves many slow, laborious operations but every chance of human error is always present. Samples are *not* representative even at an unnecessary expenditure of manpower.



HOW THE "STURTEVANT WAY" SAVES MANPOWER

Coal to be sampled is fed into the STURTEVANT AUTOMATIC COAL CRUSHER and SAMPLER where it is reduced, crushed and thoroughly mixed *mechanically*. A homogeneous, truly representative mixture leaves the "STURTEVANT" ready for the laboratory, a mixture that correctly duplicates all the proportions of combustibles and impurities that exist in the coal from which the sample is taken. The human element is eliminated, accuracy assured and manpower saved.



WHY IT PAYS TO KNOW YOUR B.T.U.'S

Only by taking accurate, truly representative samples can you know exactly the fuel value of the coal you buy, provide a correct basis for adjusting your plant to the efficient use of the coal delivered to your bunkers and assure freedom from shut down. By sampling coal the "STURTEVANT WAY" you can be absolutely certain of its B.T.U. value and thereby assure the maximum in plant performance, capacity and economy.

Investigate the "STURTEVANT WAY"—NOW!

Send at once for illustrated booklet containing valuable information on coal sampling and the big accomplishments realized in leading plants through using "STURTEVANT" automatic method.

Sturtevant Mill Co.

103 Clayton St., Dorchester, Boston, Mass.

be insulated to reduce air temperature changes. Object in covering the hot tunnel line is to prevent tunnel heat from causing condensate accumulations in the air line to evaporate into the air stream whose moisture carrying capacity (in the form of water vapor) is itself increased by heat. The objective in insulating the main in the cool east building is, of course, to prevent condensing of such water vapor as may have entered the air stream. This, however, is an extreme refinement which may not be necessary except where exceptionally dry air is needed.

(g) As an alternative to suggestion (f), where particularly dry air is required for specific work or groups of tools, install small individual commercial moisture separators at such points in the branch lines.

Tampa, Fla. FRANK FAAST

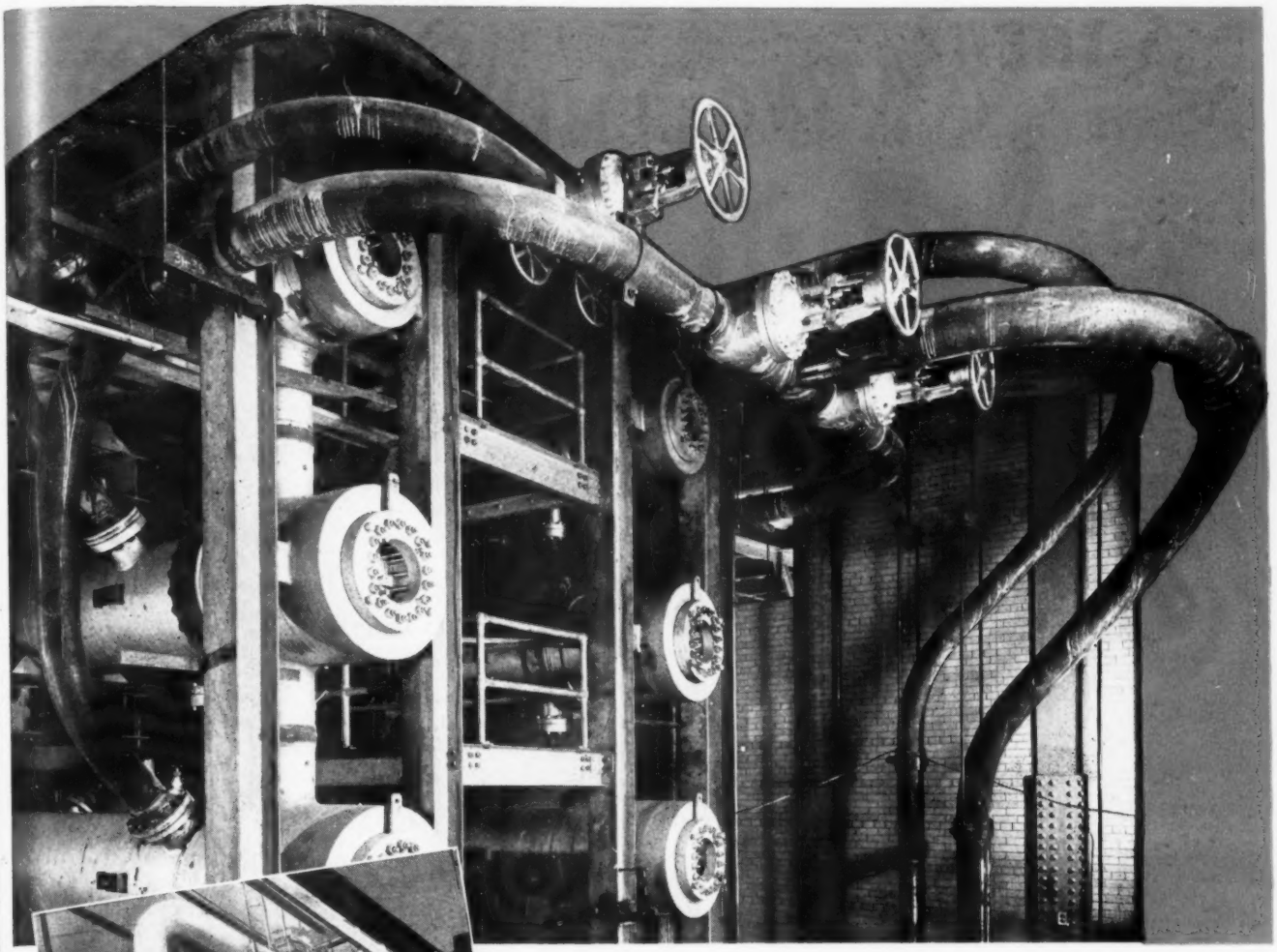
Diesel Indicators

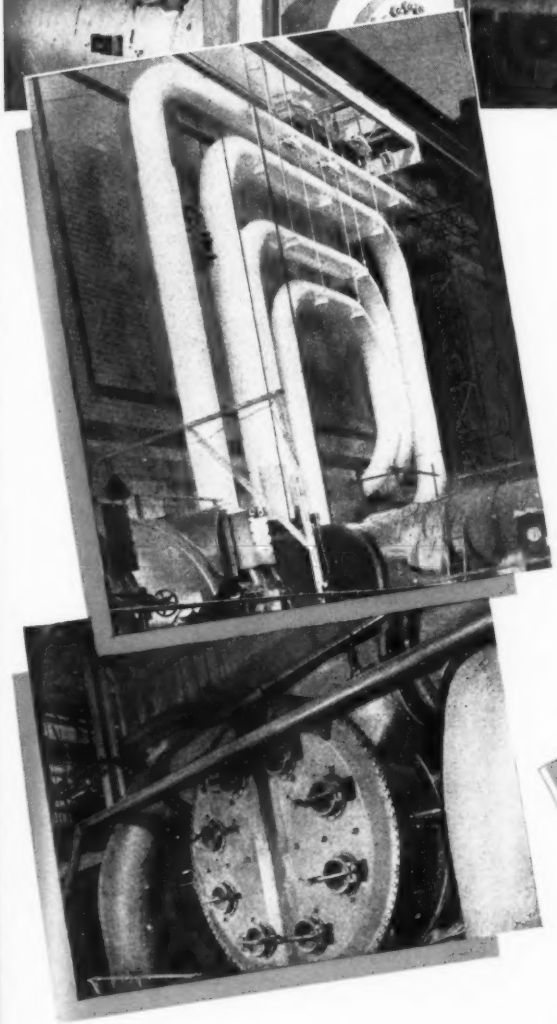
(*Continued from page* 93)

Effort expended to get cord length just right pays dividends. If cord is too long, drum reaches limit of travel before end of stroke, whereas if cord is too short, it will break or spring indicator from position when the limit is reached. To insure drum travel slightly less than the limit in either direction, jack the engine over by hand and fit the cord from both top and bottom dead centers. If engine isn't marked for centers, refer to POWER, June, 1943, pg 86, for method of finding centers.

Before mounting the indicator, open the indicator cock on the cylinder a few times to blow out any dirt or carbon clogging it. If indicator union nut carries handles, as most do, take up by hand only, to avoid distortion. Make sure that the indicator carries the proper piston and that spring has been calibrated recently. Make sure that cord does not rub or foul on pulleys.

Fit the paper to the drum, being sure to avoid grease and oil. Diagrams are small and light enough without making interpretation more difficult by smearing with fingerprints. Tighten paper on drum as shown in (5), which gives a smooth surface and puts any handling smudges outside the working area. If indicator uses pencil lead and ordinary paper, make sure that lead is good quality and keep a sharp point with a draftsman's emery stick or a small file. Some indicators use a metal stylus and specially treated paper. Keep a good stock of paper on hand and handle stylus carefully to prevent damage.





KELLOGG Solves The Most Complex Piping Design Problems

The Kellogg Scientific Method of Determining Moments and Forces Electrically has solved many of todays most complex and highly specialized temperature and pressure problems. Prefabricated assemblies designed by this scientific method are installed in public utility, process and marine power plants.

When intricate piping problems arise consult Kellogg regarding this scientific method.

M★★ KELLOGG

"Masterflex" Prefabricated Piping Systems • "Masterweld" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Hydroforming, Reforming, Dehydrogenation, Alkylation, Desulphurization. Thermal and Catalytic Polymerization Units • JUIK Processes for Lubricating Oil Plants. Plastic Refractories • Radial Brick Chimneys.

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No. 1 INSULATING CEMENT

. . . Gets Along Fine with Metal Surfaces

A special rust-inhibitor used in B-H No. 1 Cement prevents corrosion. Whether applied on a hot surface where it dries immediately or is allowed to air-dry over a long period of time, it will not attack metal surfaces. This means a permanent bond—an installation that stays put.

No. 1 Cement is sufficiently elastic to absorb ordinary expansion and contraction without peeling or cracking. Made of high-temperature-resisting, nodulated B-H *black* rockwool, long fibred asbestos, and colloidal clay, it does not form a homogeneous mass. The rockwool retains its physical characteristics and the countless number of dead-air cells provide maximum insulating efficiency up to 1800° F. Send for sample and complete data. *Baldwin-Hill Co., 575 Klagg Ave., Trenton 2, New Jersey. Plants in Trenton, New Jersey; Kalamazoo, Michigan; and Huntington, Indiana.*

Baldwin-Hill

COMPANY

HEAT & COLD INSULATIONS

Homemade Accessories

(*Continued from page* 91)

control system regulates the firing rate by latching or unlatching a dog on the stoker ram.

As for the stack temperature that Engineer Becker built from a discarded pH meter: Connecting the milliameter of the indicator in parallel with the pyrometer on one of the diesel engines enabled him to calibrate it and lay off a reference chart reading in deg F. Standard thermocouple wire fused at the end serves as the stack probe. A capped pipe containing a short piece of gage glass protects the probe from direct contact with the hot gas. Gage-glass insert acts as an insulator to prevent bare ends of the wires touching inclosing pipe.

Accuracy of the completed instrument was checked against readings of a high-temperature pencil thermometer, placed in the gas stream adjacent to stack probe. Results show the instrument to be dependable over the entire operating range, which gives the firemen another check on boiler performance.

Prior to the fuel-oil shortage, three 3-phase 60-cycle 125-kva 240-v 514 rpm diesel-engine-driven generating sets furnished necessary electric power. Oil rationing forced the shutdown of these generators and a changeover to purchased power. Incoming lines feed through a safety switch directly to the main bus. Station-generator switches are blocked open and fuses replaced with wood inserts properly tagged to prevent unauthorized or unintentional tying of the two systems.

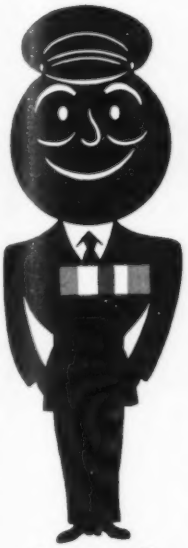
Intensive Training

Here are other evidences of Chief Engineer Becker's resourcefulness: Production machine stoppage, even for one minute, causes hundreds of dollars loss in material because it must be kept in constant movement to produce uniform thickness on the molds. His insurance against loss, when generating his own power, was to give the engineers intensive training and practice on paralleling generators quickly.

Although he does not recommend, nor did he follow, the practice except in emergencies, he trained the engineers to start and parallel a diesel-engine-driven generator in one-half minute. This is considered fast time even on a hydro unit, where a governor man starts and controls the machine while the switchboard operator does the paralleling. The fact that the engineer performs both these duties shows that the engines and

PHYSICAL AND CHEMICAL PROPERTIES

PIN A MEDAL ON *Yourself!*



"Mr. Dag"

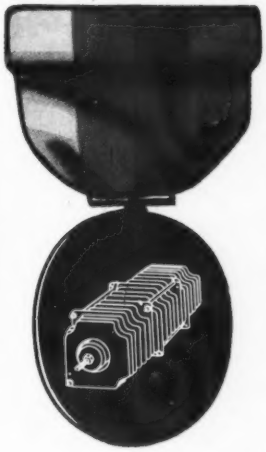
You get far more than just a smooth, black liquid concentrate when you use Dag colloidal graphite. A versatile group of valuable properties is also at your service. The most important of these properties are listed here. A color and a number is given to each for easy reference.

In the typical applications below, trace the record of some of these properties. You can do this simply by matching the ribbon colors against the property chart.

1 3 14 13 15

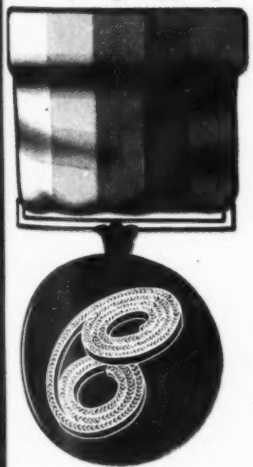
1, 3, 14, 13, 15
CITATION: "Die and punch life is increased and forgings having better finish are produced to closer tolerances with Dag colloidal graphite treated lubricants."

2 6 14 13

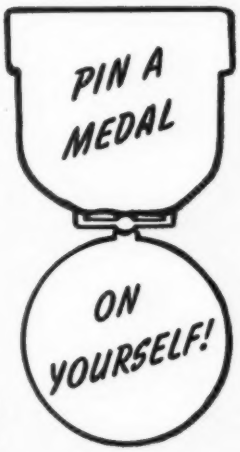


2, 6, 14, 13
CITATION: "Excellent electrical contact is obtained between copper oxide discs and adjacent metal electrodes in rectifiers when dry coatings of Dag colloidal graphite are used on the crystalline oxide surfaces."

1 2 3 14 8



1, 2, 3, 14, 8
CITATION: "Dag colloidal graphite is extensively used to impregnate asbestos packings for pumps handling chemicals and explosive fluids. It protects the packing against chemical action and provides safe, dry lubrication."



Check this list and pick out those properties which you can use. Then state your problem to us and let our engineers give you the benefit of their experience. It is quite possible that they have already studied a parallel application. You'll pin a medal on yourself for calling in Mr. Dag.

1
Slippery—a Good Lubricant. Softer than talc

2
Conducts Electricity

3
Withstands Temperature Extremes

4
Absorbs, Radiates and Conducts Heat

5
Maximum Purity

6
Low Coefficient of Expansion

7
Particles Bear Like Electric Charges

8
Insoluble in Acids and Alkalies

9
Black and Opaque

10
Gas Adsorbent

11
Little Photoelectric Effect

12
Miscible with Most Fluids

13
Films Adhere Tenaciously and Dry with Sharp Edges

14
Microscopically Fine Particles. Penetrates Fine Pores

15
An Excellent Suspension

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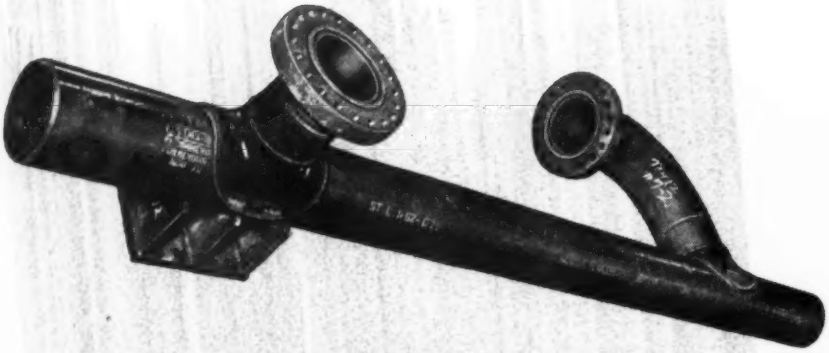
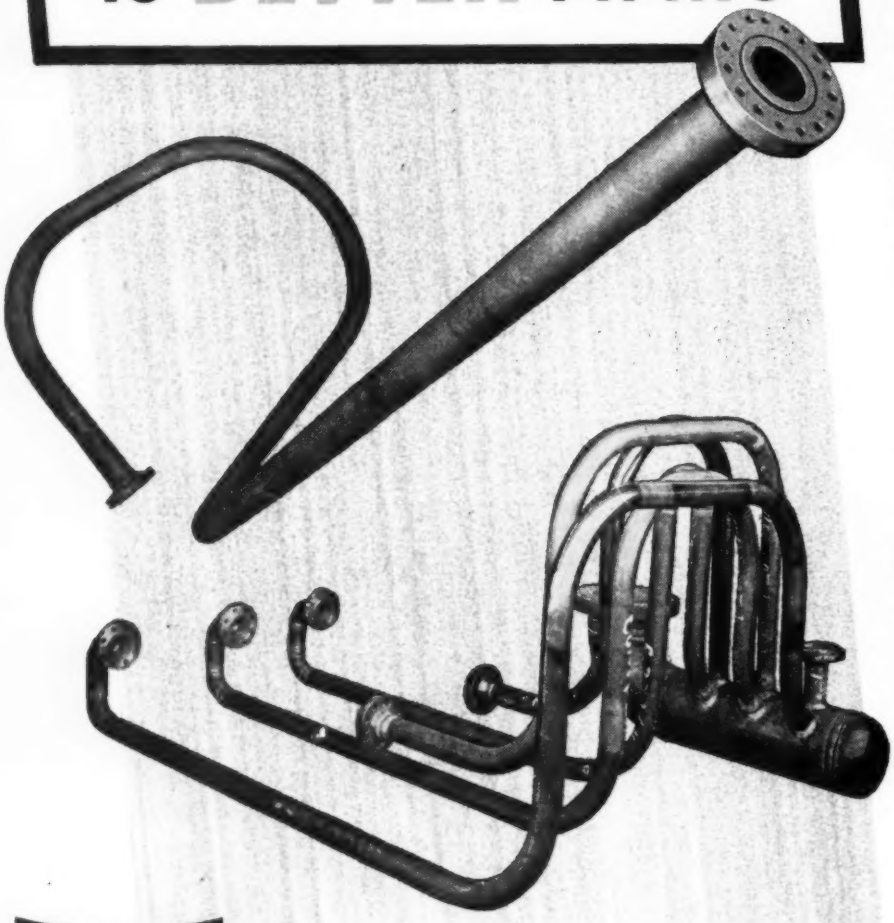
ACHESON COLLOIDS CORPORATION

PORT HURON, MICHIGAN



MIDWEST
PRE-FABRICATED PIPING
IS BETTER PIPING



Piping specialists operating complete plants using the most modern equipment and methods assure that Midwest pre-fabricated piping is accurate in dimension and alignment . . . carefully shop tested . . . thoroughly cleaned and inspected . . . and heat treated and stress relieved when necessary.

Nationwide experience in satisfying the piping needs of all types of industries and an aggressive program of piping research enable Midwest frequently to make suggestions that simplify piping layout . . . save time and materials . . . and reduce costs.

For these reasons, you will always find it advantageous to use Midwest Pre-Fabricated Piping (whether purchased on the basis of materials only or materials completely installed.)

MIDWEST
PIPING & SUPPLY CO., Inc.

Main Office: 1450 South Second St., St. Louis 4, Mo.
Plants: St. Louis, Passaic (N. J.) and Los Angeles

Sales Offices: Chicago—645 Marquette Building Houston—229 Shell Building • Los Angeles—520 Anderson St. • New York—(Eastern Division) 30 Church St. • Tulsa—533 Mayo Building.

MIDWEST PRE-FABRICATED PIPING COMPLIES WITH BOTH THE ASA CODE FOR PRESSURE PIPING AND THE ASME BOILER CONSTRUCTION CODE

"IRON FIREMAN cut our steam costs 58%"

—says Sprague Warner-Kenny Supervising Engineer

Eugene T. Molloy, *Supervising Engineer*

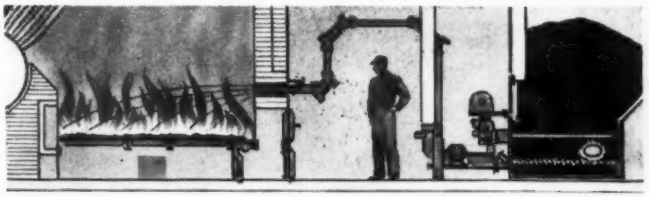
THE cost per thousand pounds of steam dropped from 62c to 26¼c, or 58%, at Sprague Warner-Kenny in Chicago when an Iron Fireman coal stoker was installed. For their food processing plant and warehouse this company installed a Pneumatic Spreader in a 400 h. p. Lasker Water Tube boiler.

This Iron Fireman Pneumatic Spreader installation replaced oil firing, and will reduce annual fuel costs from $21,266 to $8,551, resulting in a savings of $12,714 a year.

In addition, says Mr. Molloy, "With Iron Fireman our steam pressure remains more constant under loads which vary from 75 h. p. in summer to 800 h. p. in winter. Besides the saving in fuel Iron Fireman has saved us about $500 a month in labor costs."

Iron Fireman Stokers are Available . . .
See what they can do for you

In the interest of fuel conservation, and your own plant efficiency—as well as labor savings and money savings—find out what Iron Fireman can do for you. Because their performance contributes so greatly to the nation's war economy, Iron Fireman commercial and industrial stokers are in full wartime production. Our nationwide organization of qualified factory representatives and dealers is at your service. For free survey, write or wire the Iron Fireman Manufacturing Company, 3270 West 106th Street, Cleveland 11, Ohio.



The Pneumatic Spreader conveys coal in an overhead pipe from the bunker to the fire. By means of an adjustable nozzle, the coal is dropped by gravity and distributed uniformly over the entire grate surface. Sizes now available for firing commercial and power boilers up to 1000 h.p. and larger.

IRON FIREMAN

AUTOMATIC COAL STOKERS

The FRAHM VIBRATING-REED HAND TACHOMETER requires no contact with the rotating element and is unique for measuring speed of totally enclosed machines and other equipment where the end of the shaft is not accessible. The only mechanism is a set of accurately tuned steel reeds which vibrate by resonance according to the speed of the machine with which the instrument is held in contact.

This principle and the method of indication are unique among speed measuring instruments. The Frahm Tachometer is as accurate as it is simple, with no parts to wear, adjust, lubricate or renew. It can be used in any position and will give years of trouble-free service. For hand use in servicing, installation and maintenance work; also built in types for permanent mounting. Various ranges available from 900 to 30,000 r.p.m.

For a complete description of Frahm Tachometers together with lists of types and ranges commonly supplied, write for Bulletin 1710-P.

The JONES HEAVY DUTY HAND TACHOMETER is used for indicating r.p.m. and surface speeds of all types of machinery in which the moving parts are readily accessible. Simple, rugged and reliable, it is built to maintain accuracy in hard, everyday service. Scale has equal divisions throughout the 360 degrees of pointer deflection. The instrument can be operated in either direction of rotation and in any position. Single and triple range models up to 12,000 r.p.m. supplied complete with carrying case and accessories.

Write for descriptive Bulletin 1710-P.

JAMES G. BIDDLE CO. • **1211-13 ARCH STREET PHILADELPHIA 7, PA.**

their governors are kept in excellent condition. Even though forced into temporary retirement, the generating units receive close attention with weekly runs, at normal voltage and without load, to keep the windings dry.

A 200-cfm duplex 2-stage compressor supplies air for product conveying systems and automatic temperature controllers on space and process heaters. Master control elements regulate steam supplied to heaters through air-operated valves. Compressed air for diesel starting comes from a small gasoline-engine-driven hp compressor and receiver.

Power Lines

(*Continued from page* 130)

vention of Boiler Priming and Solids Carryover. W H Rowand, engineer, Babcock & Wilcox Co, New York.

Plant Maintenance H L Solberg, chairman. (a) Maintenance Systems. W A Perry, supt, electric and power dept, Inland Steel Co, East Chicago, Ind. (b) Corrosion Problems. L G VandeBogart, research engineer, research and development laboratories, Crane Co, Chicago.

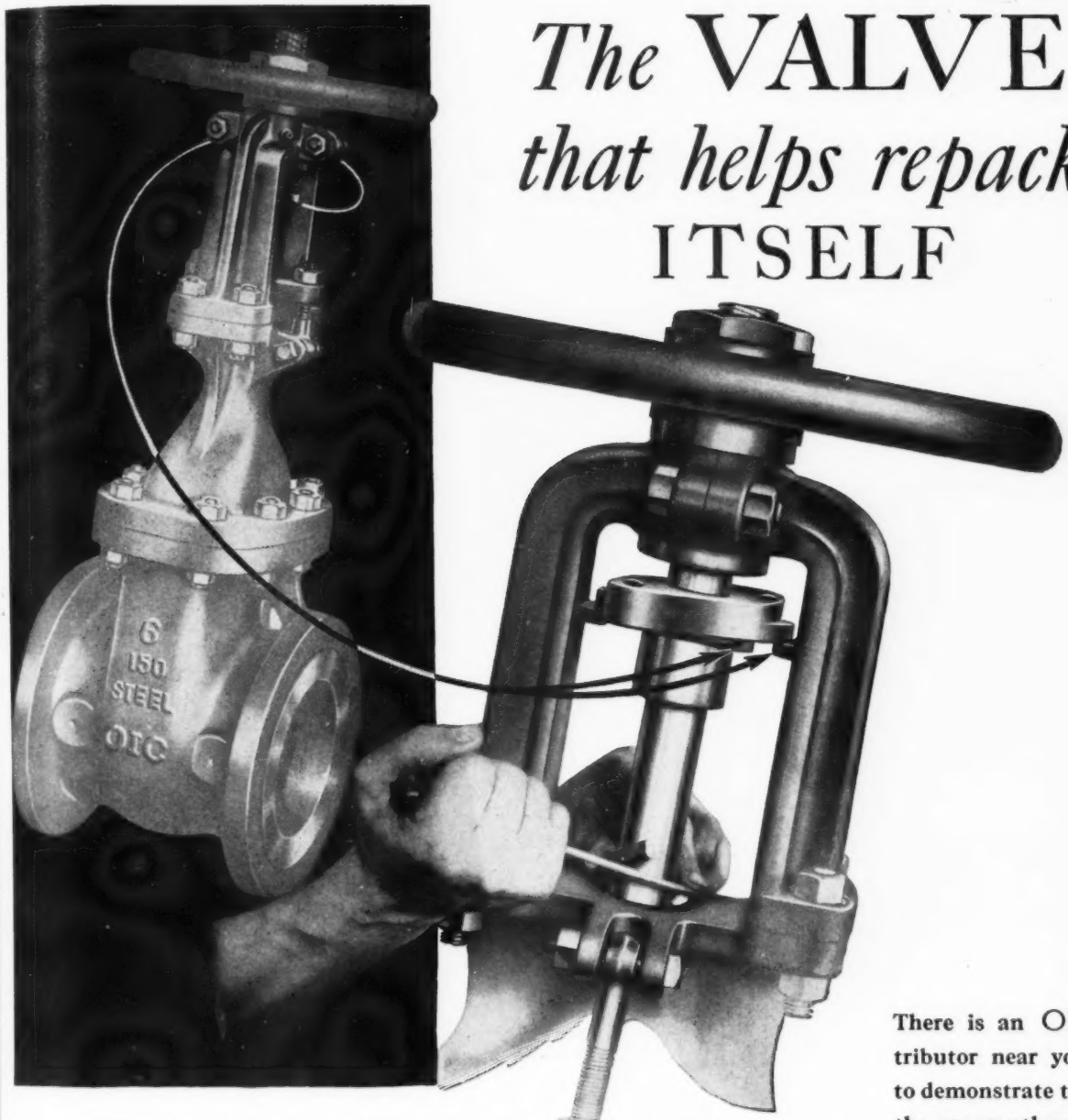
Electrical Session No. 1 J E Hobson, chairman. (a) Studies of Generator Armature Insulation Deterioration. F J Pohnan, senior testing engineer, Commonwealth Edison Co, Chicago. (b) Temperature Deterioration of Solid Insulation in Oil. F J Vogel, professor of electrical engrg, Ill. Institute of Technology.

Industrial Power Plants Hugh E. Keeler, chairman. (a) Application of Electronics to Power Generation. J D Ryder, asst professor of electrical engrg, Iowa State College. (b) Inhibitors in Condenser Tube Alloys. Austin R Zender, genl sales director, Bridgeport Brass Co, Bridgeport, Conn.

Fuels R E Summers, chairman. (a) Research in Fuels as a Postwar Necessity. A R Mumford, development and research dept, Combustion Engrg Co, New York. (b) Postwar Outlook for Oil Fuels. Arch L Foster, refinery editor, The Oil and Gas Journal, Tulsa, Okla. (c) Statistical Comparison of Fuels. C C DeWitt, chairman, dept of chemical and metallurgical engrg, Michigan State College.

Electrical Session No. 2 R W Jones, chairman. (a) Developments in the Field of Control. E H Alexander, engineer, industrial control div, industrial engrg dept, General Electric Co, Schenectady. (b) New Applications of Mer-

The VALVE *that helps repack* ITSELF



HERE'S the Steel Valve that actually helps to repack itself under pressure, enabling you to do a faster, better job.

The gland and follower are held together by self-locking lugs and are raised as one unit for repacking. The grooved ears on the gland fit into tongued shelves on the yoke when in the raised position.

Eye-bolts hold the entire unit down firmly on the packing. In the repacking process they swing down out of the way — never to be lost or misplaced.

These are just a few of the exclusive features and time and money saving advantages of OIC Steel Valves.

There is an OIC Distributor near you ready to demonstrate these and the many other features of OIC Steel Valves to you. Call him, or write to us for complete details.

ARMY (E) NAVY

OIC

THE OHIO INJECTOR COMPANY

WADSWORTH, OHIO

Quality Leaders in Valve Manufacture Since 1883

STEP UP PRODUCTION *ECONOMICALLY* . . . WITH "ON-THE-SPOT" AIR!

• In many cases, the answer to production or plant maintenance problems requiring air under pressure is to set up a rugged, smooth-running Kellogg-American unit compressor *on the spot.* No long pipe lines, air leaks and pressure drop—actual saving of power and relief to power lines.

Kellogg-American compressors are engineered to give long, economical service. Cushioned-rubber mounting for quiet operation, improved force-feed lubrication, needle type wrist pin bearings—these are but a few of the *extras* which mean *most air per dollar.*

• Models for duties at ¼ to 10 H.P., for pressures up to 250 lbs. and displacements 1.5 to 50 cu. ft. per min. Simple compressors, base-mounted motor-driven and pump and tank combinations (vertical or horizontal), portable or stationary.

Kellogg-American

REG. U.S. PAT. OFF.

AMERICAN Brake Shoe COMPANY

Kellogg Division, Rochester 9, New York

AIR COMPRESSORS • PAINT SPRAY EQUIPMENT

cury Arc Rectifiers. W E Gutzwiller, engineer in charge of rectifier application, Allis-Chalmers Mfg Co, Milwaukee.

Joint Luncheon with AIEE F E Keith, chairman. Speaker, B W Clark, vice-president in charge of sales, Westinghouse Elec & Mfg Co, East Pittsburgh, "Tomorrow's Outlook."

Diesel Power M P Cleghorn, chairman. (a) Closed Evaporative Coolers. Wm Goodman, consulting engineer, Trane Co, LaCrosse, Wis. (b) Isolation of Vibration from Diesel Plants. H H Fink, product design engineer, B F Goodrich Co, Akron, Ohio.

Celebrating the third anniversary of Eutectic Welding Alloys Co, its president, R D Wasserman, entertained members of the technical press and American Welding Society at a luncheon and demonstration of **eutectic welding.** The laboratory demonstration included making and testing different types of welds, showing the smoothness with which the metal may be applied.

Eutectic welding differs from brazing in that alloys similar to the parent metal are applied making a joint that has physical properties closely matching those of the part being welded. Special alloyed rod (for each parent metal) that melts and binds easily at low temperatures protects against grain growth, hardening, segregation and excessive oxidation.

Fluxes are chemically adapted to the respective rods so that they deoxidize the metal surfaces, assist diffusion of weld metal, reduce surface tension and melting point of the alloys. Melting of the flux indicates when to apply rod.

Check List for Paper Savers

The present acute paper shortage affects you directly as an engineer and professional reader of technical publications. Like everybody else, you can't get along without paper and will suffer by further cuts. Teamwork in your home town, and at your plant, will solve this problem. Here are some tips:

AVOID double wrapping

USE small-sized letter paper

WRITE carbons on back of letters

CLEAN out files and catalogs

SALVAGE paper boxes and wrappings

DON'T burn any junk paper

SAVE it all for collection

Here's a "GENERAL" ...WITH THE VICTORY HABIT!

JUST as certain leaders have a genius for training their men into efficient, hard-hitting, unbeatable fighting units, so Hays Combustion Control "gets the best" out of a steam power plant — makes it an efficient, smooth operating economical plant. Its automatic performance conserves man power.

Here, indeed, is a "general with the victory habit." Your Hays Combustion Control regulates every element of combustion, makes each one function at its best. It maintains a perfect balance — measures each variation, and corrects it instantly: all automatically.

Stretching steam capacity safely, getting top efficiency out of existing boiler room equipment, saving man-hours and fuel costs—Hays Combustion Control is a vital factor in meeting the extra demands put on industry by the war.

Use this capable commander in your own campaign against inefficiency and waste. The Hays Combustion Control catalog, full of helpful steam-power data, tells how. Send for it today.

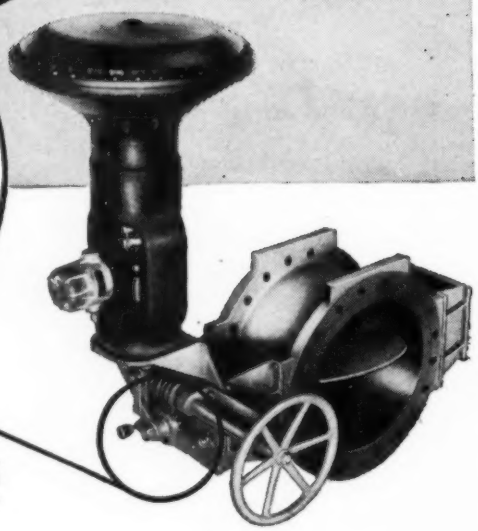
THE MODERN SYSTEM *It's Electrical*

HAYS *Automatic* COMBUSTION CONTROL

THE HAYS CORPORATION • MICHIGAN CITY, IND.

Forestall Valve Inaction

with Declutching Unit and Hand Wheel



No. 587

125-pound valve power operated by diaphragm motor. Declutching unit and hand wheel for use in emergencies.

While the majority of R-S Butterfly Valves are manually operated, they are also adapted to power operation. In such power installations, the inclusion of the R-S declutching unit (patent pending) and hand wheel has *four advantages*.

In the first place, if it is desirable to install a manually controlled valve and, at a later date, it becomes advisable to obtain some type of prime mover for automatic control, the prime mover can then be installed in the field.

If the delivery date of the prime mover can not be made to coincide with the delivery of the valve, the valve can be installed and operated at once by hand.

A power failure will cause a power operated valve to be inoperative. Such is not the case, however, when a declutching unit and hand wheel are provided.

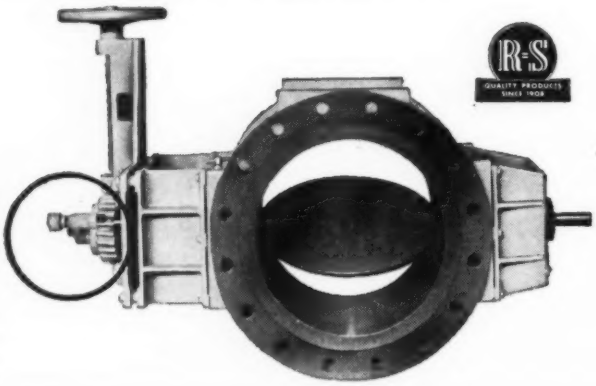
Likewise, the removal of the prime mover for maintenance, does not result in valve inaction since the valve can be operated manually at any time simply by removing the pull pin from the link which connects the diaphragm reach rod or piston to the link.

Investigate the many advantages of R-S Butterfly Valves **(15 to 900 psi)** and especially the merits of the R-S declutching unit and hand wheel.

VALVE DIVISION

R-S PRODUCTS CORPORATION

4536 Germantown Ave. • Philadelphia 44, Pa.



No. 588

125-pound valve with two outboard bearings and hand wheel control with declutching unit. Note absence of power operator which will be installed after the valve is placed in operation.

R-S Streamlined BUTTERFLY VALVES

Surplus Program Section, WPB Redistribution Div, in cooperation with the Metals Reserve Co, has published a catalog of 30,690 **new surplus steel valves** of various sizes and types, for war contractors or others. Indicated are type of valves, catalog specifications, manufacturers' names and state location. Last July, when WPB requested listings of all surplus steel valves, 108,573 new steel valves were reported for sale by user-holders. Since then 44,184 have been sold. Of the July total, holders offered 33,699 for loan, subject to replacement on specific dates. They are not listed.

The 50-page catalog, including both multi-purpose and specific-use valves, may be inspected in WPB's regional or district offices. Claimant Agencies also have copies. War contractors and others who need steel valves for war use are urged to get in touch with the nearest WPB field office, to determine whether valves they need are available. Those needing steel valves may learn their location through WPB's Surplus Program Section, 155 East 44th St, New York City. Valve manufacturers who need steel valves to supply orders may carry on dealings through Metals Reserve Co.

APPOINTMENTS

Ralph H Heberling has been appointed vice-president of **The Edward Valve & Mfg Co.** **The Lincoln Electric Co** announce the appointment of **B J Brugge** as welding engineer in Detroit and **R H Davis** as welding engineering representative in Washington, D. C. **Harold W Buus** has renewed his former position as supervisor of technical operations in the **Stearns Magnetic Mfg Co's** laboratory division. **Tube Turns** and the **Girdler Corp** announce the appointment of **Gene Wedereit** as adv manager. **Builders Iron Foundry** announce a consolidation whereby **Omega Machine Co** becomes a wholly owned subsidiary of their company. **The Weatherhead Co** announce that **H I Lewis** is executive vice-president and **Henry F Bailey** is vice-president in charge of finance.

Wright Aeronautical Corp have named **K E Sutton** manager of the Wood-Ridge warplane engine plant, while **A M Scheerer** is engrg manager. **Wm R Ford** is now asst to **L W Hutchins,** director of **Safety Research Inst.** **H E Bixby** is chief, regional branch of power utilization, **U. S. Bureau of Reclamation,** of the **Central Valleys Project.** **American Bosch Corp** announce that **Martin J Berlyn** is vice-president, in charge of engrg. **Dr Chas A Getz** has

THE WORLD'S *fastest complete* BOILER TUBE SERVICE

● More than 23 years fabricating tubes for all types and sizes of boilers—ample capacity and complete facilities for speed enables us to handle orders in dozen lots or carloads quickly—and to give accuracy and uniformity in each length, in every bend. Write, wire or phone your next order to the "World's Fastest Boiler Tube Service."

BOILER TUBE COMPANY OF AMERICA

3126 PREBLE AVENUE
PITTSBURGH, PA.

PITTSBURGH • NEW YORK • PHILADELPHIA • CHICAGO
FRED S. RENAULD & COMPANY, Los Angeles

Asbestos
Baffle Walls for longitudinal gas flow.
Enco Patented Baffle Walls—designed for cross flow of gases giving more efficient results.
Enco Baffle Wall Design and Construction is Patented and is produced exclusively by The Engineer Company.
Asbestos

CORRECT BAFFLES SAVE FUEL!

Too often it is found that the Baffle Walls in existing boilers were originally located with a view to low cost of installation rather than in the most effective position for efficient results.

Enco Baffles increase steam production, improve boiler performance and save fuel, by streamlining the cross flow of gases over the boiler tubes through passes that are correctly proportioned to maintain the proper velocity and heat transfer, utilizing every square foot of heating surface.

Bottle necks and dead gas pockets are eliminated and draft losses reduced. The rapid flow of gases across the heating surface tends to clean the tubes, cutting down use of soot blowers — a further saving in steam.

It may be we can design and build a better baffle wall for *your* water tube boiler. Our experience of 25 years in this highly specialized branch of engineering is available to you.

Send us your boiler print and ask for a new baffle design. No obligation to you.

FREE BOILER BAFFLES

ENCO STREAMLINE BAFFLES
Produced exclusively by The Engineer Company

● ***A bulletin on boiler baffles gives valuable information which every engineer should have. Ask for bulletin BW 44. It's free.***

THE ENGINEER COMPANY
75 WEST STREET • NEW YORK 6, N. Y.

Enco Streamline Baffles
PRODUCED EXCLUSIVELY BY THE ENGINEER COMPANY

been elected vice-president, in charge of research, **Cardox Corp.** **Lt Col Cecil P Young,** U. S. A. ret, is executive vice-president, **Wickwire Spencer Aviation Corp,** subsidiary, Wickwire Spencer Steel Co. **Stone & Webster Engrg Corp** announce that **Frank R Creedon** has been appointed construction manager. **The Austin Co** has named **Roy E Ward** and **Frank W Maynard** vice-presidents. **Farrel-Birmingham** appoints **Albert W Hendrickson** director of employe services. **James D Cunningham** has been elected to the board of directors of **Allis-Chalmers Mfg Co.** **Leroy H Barnard** is asst supt, **United Koppers Corp.** **The McClave Co** announces that **B W Paul** is manager of sales of their Chicago metropolitan office, replacing W S Elder.

A J Baker will be plant manager in DuBois, Pa., newest **B F Goodrich** unit to manufacture rubber and textile products. The company recently announced that a **new tire mfg plant** would be built in Miami, Okla. Appointments in the recently created chemical div of The B F Goodrich Co are: **Wm I Burt,** genl manager of plants; **Dr Frank K Schoenfeld,** director, technical and development; **Dr Victor E Wellman,** director of purchases, **Harry E Foster,** general auditor. **W S Richardson,** genl manager of the chemical div, has been elected vice-president, **Hycar Chemical Co** in addition to his duties with Goodrich.

The Timken Roller Bearing Co announces that: **John E Fick,** supt, steel and tube div, has become vice-president in charge of the same div. **A M Donze,** factory manager, has become vice-president in charge of production. **Walter G Hildorf,** who recently became director of metallurgy, is the first to occupy that newly created office.

Young Radiator Co (heat transfer products for building, aircraft, automotive, and related fields) have appointed **W P Nevins Co** as sales and engrg representatives in Chicago. **Simplex Valve & Meter Co** have appointed sales representatives in the following territories: **Carl F Noel,** Oakland, Calif.; **Case Eng Co,** St. Louis, Mo.; **R S Stover,** Marshalltown, Iowa; **"Jim" Clark Agency,** Milwaukee, Wis.; **R O Luchtenberg,** Columbus, O.

F Paul Anderson Medal has been awarded to **Dr Ferry C Houghten,** Lt Commander, U. S. Naval Reserve, by the **ASHVE,** for "outstanding research over a long period of years in the fields of heating, ventilating and air conditioning."

For a joint that's PERMANENT — yet readily disconnected...

WIDELY USED FOR
Butane
Propane
Freon
Ammonia
Brine
and many other services

Use

JOHN CRANE *Insoluble* PLASTIC LEAD SEAL

This multi-purpose pipe-joint compound is insoluble in oil, gasoline, steam, water and many other liquids and gases — hence Plastic Lead Sealed joints are *permanent*. Does not harden or set with age; prevents corrosion — hence old joints are broken as easily as new. Smooth, free-spreading—readily fills all clearances. Remains plastic; unaffected by vibration or temperature changes. Send for test sample (mention service intended) and see for yourself.

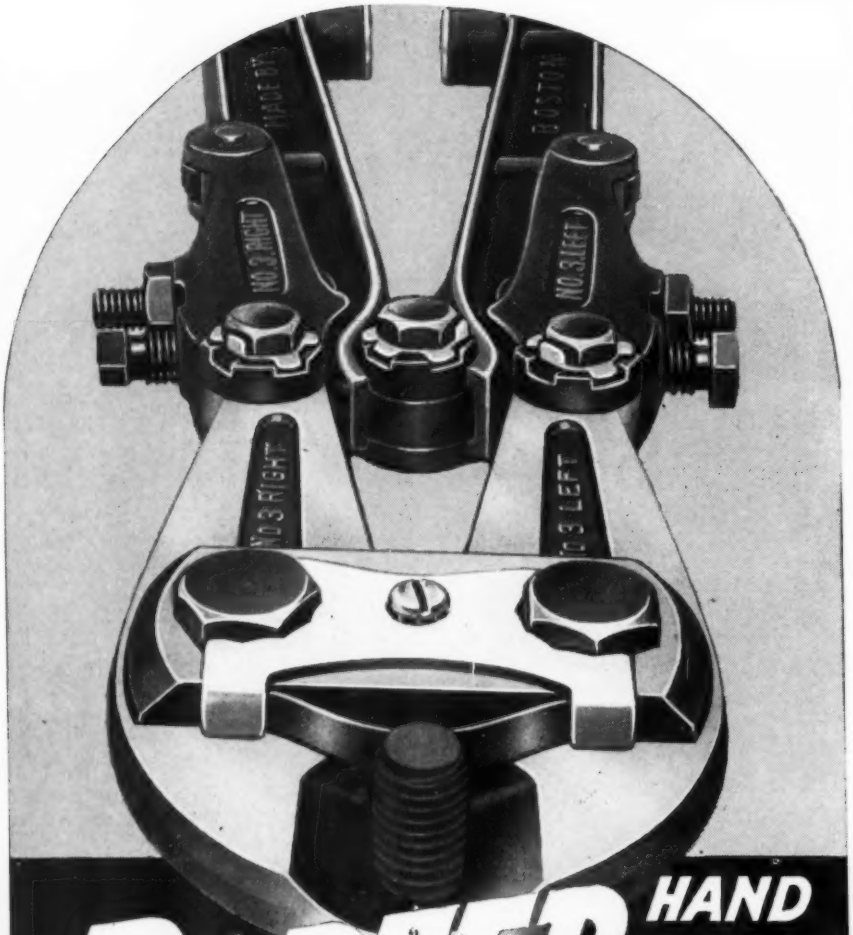
Packed 1 and 7 lbs., ready for use.

CRANE PACKING COMPANY

1811 CUYLER AVE. • CHICAGO 13, ILL.

BALTIMORE, BOSTON, BUFFALO, CLEVELAND, DALLAS, DETROIT, HOUSTON, LOS ANGELES, NEW ORLEANS, NEW YORK, PHILADELPHIA, PITTSBURGH, SAN FRANCISCO, ST. LOUIS, TULSA

CRANE PACKING CO., LTD., Hamilton, Ontario, Canada.
Branches: Montreal, Toronto, Vancouver



PORTER HAND POWER CUTTERS

These tools go *to* the job and are used *on* the job independent of any power source — except a worker's two hands. This power is so multiplied that an average worker can exert sufficient pressure to "lift an elephant —."

This power delivered at the working head finds many applications in metal cutting and fabricating — emergency, repairs, on construction, shop or production.

The illustration above shows a Porter Bolt Clipper head cutting a 5/8" annealed bolt in the thread. In addition to standard tools for cutting wire, cable, chain, flat bars, splitting nuts, etc. there are special tools for Heading, Pressing, Crimping, Punching, Caulking.

FREE —Write for Free copy of Tool Maintenance Book—boiled down essence of practical experience in use and care of clippers, saws, chisels and other hand tools. A post card request will bring it postpaid. *Also write for catalog of Porter line of Cutters.*

H. K. PORTER, INC., 425 Ashland St., Everett 49, Mass.

PORTER HKP CUTTERS

OBITUARIES

Allan E Hall, 70, manager, milling machinery dept, Allis-Chalmers Mfg Co, died Jan 17 after an illness of several months.

Jas E McDonald, 53, genl sales mgr, The Edward Valve & Mfg Co, died Feb 25 after being ill several months.

Newton S Taylor, 55, an executive in the switchgear and control div, Westinghouse Elec & Mfg Co, died Feb 21 after an extended illness.

Daniel B Tweed, supt, Salisbury district, Duke Power Co, died Feb 5 from a heart attack, at the age of 42.

Herbert W Scott, 56, for over 25 years a stationary engineer on the Boston & Albany railroad, died Jan 31.

Frederick J Macwilliams, 49, died following an extended illness. He was one of the founders in 1931, and genl mgr, Abart Gear & Machine Co.

Chas P Rhine, 60, died Jan 17. He was division maintenance engineer, San Joaquin power div, Pacific Gas & Elec Co.

Fred L Hunt, 64, vice-president in charge of operations, Western Mass. Companies system, died on Feb. 8.

G L Montgomery, associate editor, *Food Industries,* died suddenly on March 4. He became an editor in 1922 when he joined the staff of *Chemical & Metallurgical Engineering,* another McGraw-Hill publication. From there he came to the staff of POWER in 1927 as associate editor.

His principal professional interest was the equipping and operation of manufacturing plants in the food industries.

He was known as an authority on materials handling, as witness his section in the *Chemical Engineers Handbook.* Around the office, he was noted for the encyclopedic range of his general and specific knowledge.

Mr. Montgomery was graduated from Columbia University as a mechanical engineer in 1912. At the time of his death he was secretary, N. Y. section of Institute of Food Technologists. He was chairman, food section of ASME, a member of the Metropolitan Dairy Technologists Assn, and of the N. Y. section of American Assn of Cereal Chemists. He also did consulting engineering work. He was vice-president, McGraw-Hill Employees Credit Union; secretary-treasurer, Port Washington Consumers' Cooperative Group.

NICKEL AIDS THE ELECTRICAL EQUIPMENT INDUSTRY

to KEEP 'EM OPERATING!

ELECTRICAL ENGINEERS continue their spectacular progress.

Since Pearl Harbor they have designed and perfected equipment that frees military strategy from many of its old limitations.

Through tireless motors big and small, through tiny electronic tubes and gigantic motor generators, through a myriad of instruments and machines these men have put electrical energy to work for Victory.

Constantly striving to improve its products, the electrical industry has acquired long experience with metals and alloys of many kinds.

This experience has demonstrated that when properly used, nothing quite takes the place of Nickel. From resistor grids to armature shafts, from limit switches to reduction gears, Nickel and its alloys have been assuring the dependability so important in equipment that must not fail . . . even under wartime overloads.

Nickel imparts toughness, strength, and fatigue resistance to other metals . . . makes them stand up better under abrasion, wear, shock, and stress.

As in other industrial fields, a little Nickel goes a long way to keep electrical equipment operating.

For years we have enjoyed the privilege of cooperating with technical men of the electrical equipment industry . . . and of many others. Whatever *your* industry may be . . . if you want help in the selection, fabrication, and heat treatment of alloys . . . we offer you counsel and data.

New Catalog Index

New Catalog C makes it easy for you to get Nickel literature. It gives you capsule synopses of booklets and bulletins on a wide variety of subjects — from industrial applications to metallurgical data and working instructions. Why not send for your copy of Catalog C today?

* *Nickel* *

THE INTERNATIONAL NICKEL COMPANY, INC., *67 Wall St., New York 5, N. Y.*

MURRAY

Type UG

INTEGRAL GEARED TURBINE

• Type "UG" Integral Geared Turbine consists of the Type "U" Mechanical Drive Turbine (see features below) with integral single or double helical reduction gear. Turbine is supported by the gear at the turbine shaft centerline thereby avoiding misalignment due to the heating of the turbine casing,

View shows unit equipped with variable speed direct acting oil pump governor and extended low speed shaft with sheave for V-belt drive.

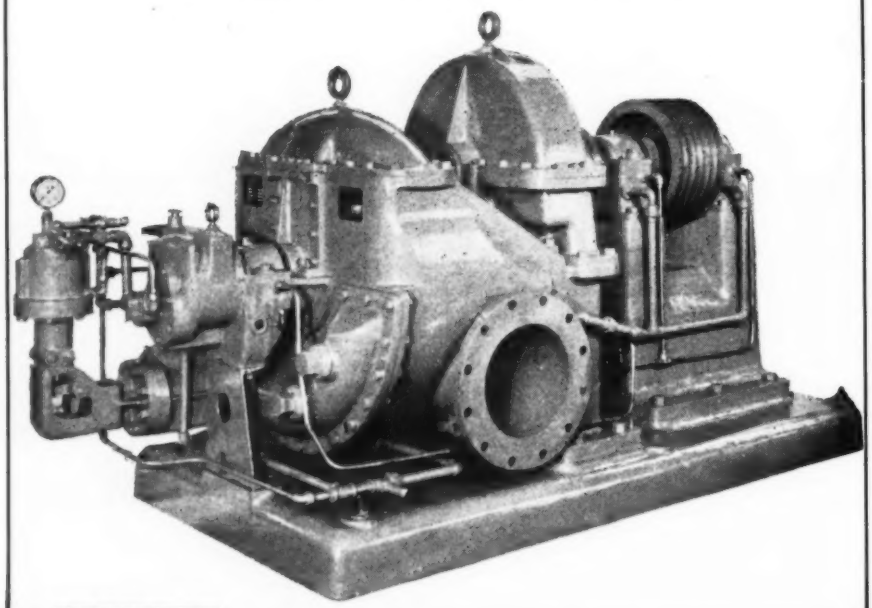
Three highly desirable features in

MURRAY TYPE "U" MECHANICAL DRIVE TURBINES

1. Longer steam ring allowing considerably more nozzle area and large steam inlet size, thereby increasing the maximum horsepower developed by a particular frame.

2. Larger exhaust opening which permits of greater horsepower and improved efficiency, particularly for condensing operation.

3. Additional hand valves for nozzle control. (There are three hand valves on our smallest frame, whereas the usual small conventional turbines has room for only one.)



MURRAY
IRON WORKS COMPANY
INCORPORATED 1870
BURLINGTON IOWA

This American convoy scene in full color has been painted by Chas Rosner, noted marine artist, for Peabody Engrg Corp. In the foreground are a Canadian K boat and a new American Victory Ship. The picture appeared in an advertisement in POWER's Feb issue. A full color reproduction on heavy paper, containing no advertising and suitable for framing, will be sent free to any one writing for it to the Peabody Engrg Corp, 580 Fifth Ave, New York 19, N. Y.

An index of POWER for the twelve months of 1943 is now available to subscribers on request.

Army-Navy E pennants were awarded to:
Pittsburgh Piping & Equipment Co, Feb 25
Hanlon-Waters, Inc, Jan 31
Air-Maze Corp, Feb 17
In a dual ceremony, wiring device div and plastic div, *Bryant Elec Co*, a subsidiary of Westinghouse Elec & Mfg Co received pennants.
Cochrane Corp, Feb 15

White stars (Army-Navy E renewals) to:
Brown Instrument Co; div of Minneapolis-Honeywell Regulator Co, 1 star.
Alloy Steel Products Co, 1 star, Dec 31
Handy & Harman, 3 stars, Feb 29
Worthington Pump & Machinery Corp, 2 stars to one plant, 3 stars to another, and 4 stars to their Harrison, N. J. works.

M pennant of U. S. Maritime Commission now flies over *C Lee Cook Mfg Co*, Jan 22.

Superior-plant-guard guidon to *Whiting Refinery, Standard Oil Co of Ind.*, Feb 18.

Second gold star has been added to the M pennant of ***Edward Valve & Mfg Co.***

Vincent A Sheals has been made designing engineer, cable engrg div, **General Electric's** Schenectady works. **Reynolds Metals Co** have elected **C Davis Blackwelder** vice-president. **Sylvania Electric Products, Inc,** have enlarged their Warren, Pa., plant, with **Arthur L Chapman** succeeding **R W Beal** as manager. **J S F Carter** is engineer in charge of design and engrg service, process div, **S D Hicks & Son Co.**

You can't take one away from the other—the Steel, the Rope, the Men who make it, engineer it, and apply it to the drums and sheaves. They add up to rope service ● **ROEBLING** *"Blue Center"* **STEEL WIRE ROPE**

WHAT CAN YOU EXPECT from Roebling? Rope that has known capacity to deliver service. Engineering, in our plant and at your job, to put the rope to work right. Maintenance practices that protect its long life. » » Your postwar profits and postwar jobs will depend in part on operating rope-rigged equipment at lowest cost. You can leave that part to Roebling.

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PACEMAKER IN WIRE PRODUCTS

WIRE ROPE AND STRAND • FITTINGS • AERIAL WIRE ROPE SYSTEMS • COLD ROLLED STRIP • HIGH AND LOW CARBON ACID AND BASIC OPEN HEARTH STEELS • ROUND AND SHAPED WIRE • ELECTRICAL WIRES AND CABLES • WIRE CLOTH AND NETTING AIRCORD, SWAGED TERMINALS AND ASSEMBLIES • SUSPENSION BRIDGES AND CABLES

We Didn't Want to Make Strainers

BUT we needed them for use with Yarway Steam Equipment and couldn't find any to suit us.

So we designed the *YARWAY Strainer.*

Apparently a lot of other people were having "Strainer trouble" because, without a line of advertising, the Yarway Strainers *purchased* in a few years now number *many thousands.*

Why don't you look into this better Strainer for your money? Buy one from your supply house (over 100 Mill Supply Houses now have them).

See its protection against corrosion—*cadmium plating inside and out.*

Examine its *high grade Monel woven wire screen* that stops dirt—lets condensate or other fluids flow freely.

Notice the removeable blow-off bushing. Screen and bushing come out together—go back together, *automatically aligning.*

Six standard sizes from ½" to 2" for pressures to 600 lb.

See your Mill Supply House or write for Bulletin S-200

YARNALL-WARING COMPANY
100 MERMAID AVE. PHILADELPHIA 18, PA.

YARWAY STRAINERS

New Equipment

(*Continued from page* 126)

guides. Heads are cast of Meehanite. Engine bed and cylinder block are of welded steel; deep bed sections, heavily ribbed, provide rigidity for bearings.

Cooling water enters cylinder jackets from a header. High velocity is obtained at liner top and heads are so cored that water has a jet action around the injectors. On marine models, reversible centrifugal pumps circulate raw and fresh cooling waters. Tubular heat exchangers with fresh- and raw-water pumps and complete piping form integral parts of these diesels. Water-cooled exhaust manifolds on both marine and stationary models are of welded-steel tubing. Pyrometer thermocouples at exhaust outlets and cylinder-head thermometers are provided.

Crankshaft Construction

The large-diameter crankshaft may be either a solid steel forging or a hollow alloy casting. Main bearings are centrifugally cast, babbitt lined and steel backed, easily removable without disturbing crankshaft or other bearing caps. Between two main bearings at the flywheel end is the camshaft and governor driving gear. One section of camshaft-drive chain connects driving sprocket and shaft of the chain-adjustment assembly, and the second goes from the chain-adjustment assembly to the camshaft.

Lightweight cast Meehanite pistons carry deep ribbing on underside of crown for oil cooling. Bronze wristpin bushings are pressed into pistons. Forged-steel connecting rods have marine big ends, with removable split babbitt-lined bearings; four alloy-steel bolts hold cap. Small end carries a removable hard-alloy bronze bushing. Rods are drilled for force-feed lubrication of wristpins and for piston cooling.

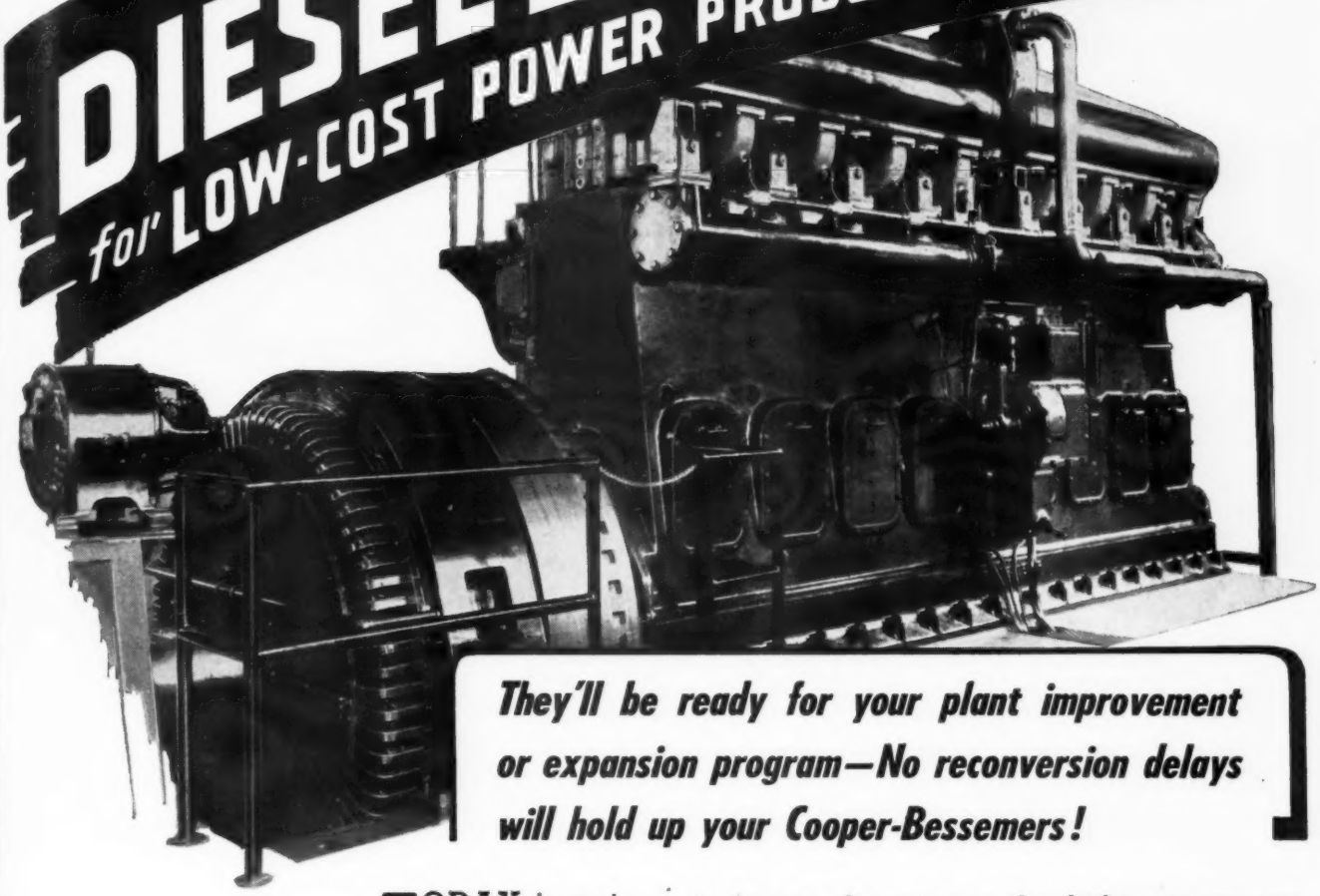
In the full pressure-lubrication system, a scavenging pump removes oil from the crankcase to an external reservoir, and a separate pressure pump supplies oil from this tank to main bearings, rod bearings and pistons, with individual lines going to camshaft, rocker arms and other parts.

Each cylinder carries an air-starting valve to which air is admitted from a corresponding pilot valve driven by the camshaft. Cage-type relief valves can be used as compression release and provision is made for attaching a pressure indicator. Mechanical or hydraulic governor, gear driven from flywheel, regu-

Order NOW

DIESEL ENGINES

for LOW-COST POWER PRODUCTION .....



They'll be ready for your plant improvement or expansion program—No reconversion delays will hold up your Cooper-Bessemers!

TODAY is not too early to talk about your future power requirements—about diesel power.

Diesel power has come of age in this war. Diesel engines of many types and sizes are turning in amazing performances all over the world, in ships of every kind, in utilities' central stations, factories, mines and oil fields.

In your own business, there are power jobs that can be done expeditiously, economically by diesel — driving generators, or pumps, or blowers, or compressors. Now is the time to determine what you need and take steps to get your engines earmarked for quick delivery.

Cooper-Bessemer has diesel engines to sell. Right now our factories are devoted 100% to government contracts and high priority orders. But our advance manufacturing program is forming now. Our plants have no reconversion problems. We are ready to serve private industry the minute the light goes green.

The engines you get will be all the better for our 100% war experience. They benefit from the concentration of ten years normal engineering development crowded into two or three. They will give you the same outstanding service that diesels are delivering today on the war and production fronts.

We are ready now to figure on your present and future power requirements. Ask for our representative, to sit down with you at your convenience, to determine what types and sizes you'll need. Let's make a start on your problem now.

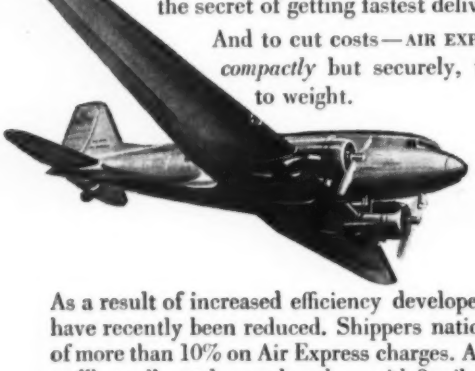
THE Cooper-Bessemer CORPORATION

Mt. Vernon, Ohio • Grove City, Pa.

BUILDERS OF DEPENDABLE ENGINES FOR 111 YEARS

ANY AIR EXPRESS shipment that's packaged, labeled and ready to go ...SHOULD GO! Don't let it SIT! Call AIR EXPRESS right away...instead of waiting for "routine" afternoon pick-ups. Your shipment thus avoids end-of-the-day congestion when Airline traffic is at its peak. That's the secret of getting fastest delivery! SHIP WHEN READY!

And to cut costs—AIR EXPRESS shipments should be *packed compactly* but securely, to obtain the best ratio of size to weight.



A Money-Saving, High-Speed Tool For Every Business

As a result of increased efficiency developed to meet wartime demands, rates have recently been reduced. Shippers nationwide are now saving an average of more than 10% on Air Express charges. And Air Express schedules are based on "hours", not days and weeks—with 3-mile-a-minute service direct to hundreds of U. S. cities and scores of foreign countries.

WRITE TODAY for "Vision Unlimited"—an informative booklet that will stimulate the thinking of every executive. Dept. PR-4, Railway Express Agency, 230 Park Avenue, New York 17, N. Y.

AIR EXPRESS
Gets there FIRST

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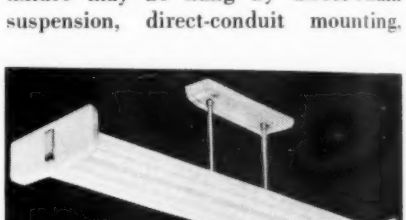
Representing the AIRLINES of the United States

lates speed. Starting and operating controls center at a gage board which carries a tachometer, fuel, lubricating-oil and air-pressure gages, pyrometer and reversing controls for marine engines.

For marine use, both direct and reduction-gear models have Timken marine thrust bearings, force-feed lubricated from engine and built either as integral parts of engine or reduction gear. Hendy planetary reduction gears or Farrell-Birmingham continuous-tooth single reduction gears are available as optional equipment. A flexible coupling stands between flywheel and gears in either model. For power takeoff, an optional friction clutch, at opposite end of engine from flywheel, permits taking up to 20% of rated horsepower. *Joshua Hendy Iron Works, Sunnyvale, Calif.*

Fluorescent Fixture

MODEL HF-235R for two 100-w lamps is of the same basic streamlined design as recent 40-w-lamp units. Suited to individual or continuous-row mounting. fixture may be hung by direct-chain suspension, direct-conduit mounting.



messenger cable-clamp assembly, or surface mounting with bolt or lag screw. Top housing incloses ballast for protection, and complete hanging flexibility is assured through ½-in. knockouts located on 24- 30- 36- and 47¾-in. centers. Chain-hanging brackets are also built into top housing. Single piece of non-metallic reflector board, finished in Miracoat high-temperature-baked enamel, furnishes high reflectivity. Maintenance ease is guaranteed by convenient location of starters between lamps and by the fact that a quarter-turn of *captive latches* will remove reflector from top housing. *Lighting Div. Sylvania Electric Products Inc, Salem, Mass.*

Air-Circuit Breaker Slide Rule

UNIT-SUB RULE determines correct size air-circuit breakers for all industrial substation applications. Slide rule for calculation of interrupting capacity of 600-v class air-circuit breakers. Rule, constructed from standard AIEE formulas for determining short-circuit cur-

WANT TO GO SHOPPING ?

What's happened to prices? It would be mighty unpleasant for our America to slide into a situation where you had to pay these prices for these familiar products. Of course, it wouldn't happen overnight. It would happen slowly, insidiously. That's the way it *is* happening.

Of course the greatest catastrophe wouldn't be just the higher prices of the familiar American products shown here. It would be the drop in the value of money. Your money in the bank would *shrink*. Your life insurance would be worth *far less*. Your pay check —well, you know what's happening to it already.

There are three ways we can stop this creeping, soul-destroying monster from taking America over. Read them carefully: 1—*Encourage* our representatives in Washington to tax our extra income away. (*Sure it's hard, but not as hard as Inflation, and saddling our children with the war's cost!*) 2—Give wholehearted support to Government price-control agencies. (*Sure they've made mistakes, but they're the best we have and they can do the job if we support them.*) 3—Get along on as little as you can. Deny yourself—to buy War Bonds. (*The suckers are the ones who are spending, not the ones who are saving. Think that through.*)

If you have the courage to do these three things, America can go right on being the America we've always known.

Have you . . . ?

ROGERS DIESEL AND AIRCRAFT CORPORATION

1120 Leggett Avenue, New York 59, N.Y. Builders of diesel-electric equipment and aircraft parts for the armed forces. *Divisions:* Hill Diesel Engine Company, Edwards Company, Edwards Aircraft Products, Inc., Ideal Power Lawn Mower Company.

Diesel Engines, 5 to 2000 h. p. » Gasoline Engines » Generator Sets » Generators » Power Units Switchboards » Pumping Units » Hydraulic Aircraft Equipment » Recoil Mechanisms » Power Mowers Power Brushes » Snow Removal Equipment » Streamlined DeLuxe Railway Motor Trains » Diesel Locomotives

TRADE MARK REG.

A word of thanks to the famous American makers represented above, who have permitted us to associate their products with prices upped fivefold—an increase that is small, compared to what happened in inflated Germany, when a loaf of bread cost a million marks!

COMPLETE REPRINTS of this message for poster use will be supplied upon request, subject to the limits of our paper allotment.

Send out a Posse'
to locate your Old Darts

. . . For Used Darts Can Be Used Again!

The search goes on—in plants from coast to coast—to hunt out and find old Dart Unions. And here's why: even the Darts that have been used time and time again can give tight-joint performance. This is real economy for the plants . . . and don't forget . . . by putting used Darts back on the job, you are helping to conserve metal and hasten the day of Peace.

The explanation of how Dart's can pay extra dividends in trouble-free performance and long life lies in these facts. Dart's matched bronze seats, precision machined and ground to accurate "true-ball" surfaces make it possible for Darts to be used so many times. Dart's Nuts and Bodies, made of heavy air refined malleable iron gives Darts their ability to resist rough handling and pipe strains.

So keep looking—for the reward is well worth the search. And if you need *new* Darts, your supplier will see that you get them as soon as possible.

DART UNIONS

E. M. DART MFG. CO., Providence, R. I.

rents, takes into consideration all necessary factors, such as motor load and dc component. While slide rule has been specially developed for load-center unit substation applications, it may check breakers on any system. It applies to direct-connected as well as cascaded breakers. Write direct to manufacturer for rule. *Allis-Chalmers Mfg Co. Milwaukee, Wis.*

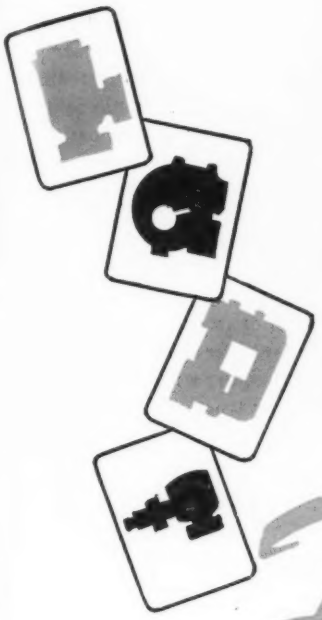
Combustion Control

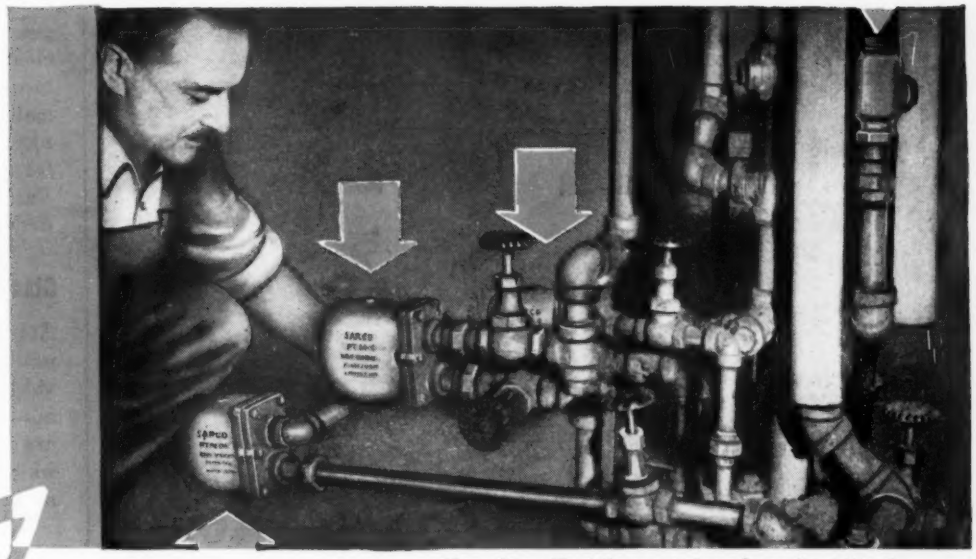
TYPE P COMBUSTION CONTROL, for the smaller industrial and municipal power plant, applicable to boilers fired with coal, oil or gas. System continuously proportions fuel and air to steam demand and at the same time controls furnace pressure. To regulate fuel feed and draft (either forced or induced) system provides a simple electrical balance by which the settings of valves, dampers or vanes are varied in definite

proportion to steam demand as directed by master controller. Remaining draft damper or other device is simultaneously regulated by furnace-pressure controller. If operator does not desire full automatic control, he can move any of the drive units from pushbutton stations. Independent operation of drive units allows controllers to be serviced without interrupting boiler operation. *Leeds & Northrup Co,* 4934 *Stenton Ave, Philadelphia* 44, *Pa.*

Insulated Pinion Gears

TO STOP TRANSMISSION OF NOISE, shock vibration and impact, pinion gears are insulated from shafting by applying a rubber bushing directly between gear and shaft. Considerable cost is saved as the rubber or synthetic can be inserted without the usual inner and outer metal sleeves. Two machining operations normally required, milling keyways or flats, are eliminated. No special preparation of shafting or gear for process. Synthetic (or rubber) after it is in position, provides a mechanical bond with

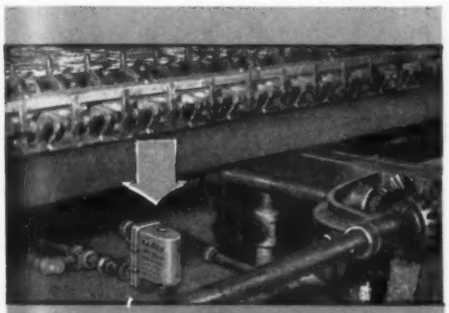


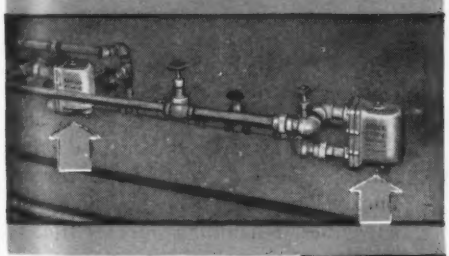


Three Sarco Float-thermostatic and one Sarco No. 9 on ager

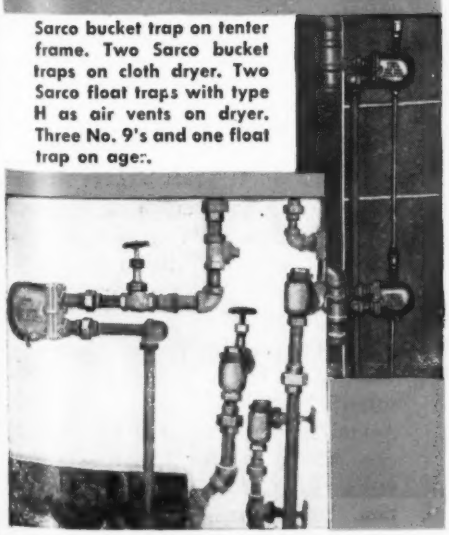
Four SARCO ACES

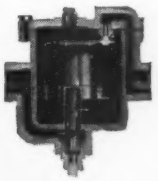
IN THIS TEXTILE PLANT



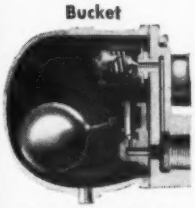


Sarco bucket trap on tenter frame. Two Sarco bucket traps on cloth dryer. Two Sarco float traps with type H as air vents on dryer. Three No. 9's and one float trap on ager.

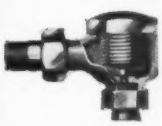




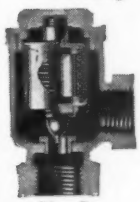
Bucket



Float-thermostatic



H trap



No. 9

If you don't want to gamble with your production output, you will see that every steam operated machine in your plant is provided with *exactly* the right kind of steam trap.

The illustrations show how four different types of Sarco traps work together like a team to provide smooth uninterrupted flow of production in this silk printing plant.

The Sarco No. 9 thermostatic trap is used for steam coils on dryers and similar operations where the load is reasonably steady. The Sarco Bucket trap was selected for the rolls and where the load fluctuates widely. The Sarco Float trap is employed to drain all steam lines and the little Sarco Type H is used for an air vent wherever one is needed.

As individual "Aces", or as teams of four, Sarco steam traps have been meeting industry's needs for a quarter of a century. They are made in a modern factory devoted exclusively to steam traps and temperature control.

The Sarco representative near you can give you the benefit of many years of experience in plants like yours, and can tell you which Sarco trap will be best for each job.

SARCO COMPANY, INC., 475 FIFTH AVENUE, NEW YORK 17 N.Y.

Represented in Principal Cities

SARCO Saves Steam

SARCO CANADA, LTD., 85 Richmond Street, West, TORONTO, ONTARIO 24

SAVE COAL

—with FYR-FEEDER Multiple SPREADER Stokers

FYR-FEEDER stoker firing not only saves coal, but also permits you to burn any kind of wet or dry bituminous coal you have available locally—screenings or sweepings, any melting point of ash, free-burning or coking coals.

Burns Coal like Oil: FYR-FEEDER burns fines in suspension, burns larger pieces on grate. Coal is spread over entire fuel bed. Thin fuel bed—no clinkers. Fires can be cleaned in two minutes! Suitable for large or small boilers. Very little maintenance cost. In many cases FYR-FEEDER stokers have made it unnecessary to add another boiler to handle increased loads.

FYR-FEEDER is **our own original** design. FYR-FEEDER is not a copy of any other stoker but our own invention developed by us, and our engineering experience with spreader stoker design, installation and operation began in the last century.

WET COAL IS NO HANDICAP

Coal men like the FYR-FEEDER because FYR-FEEDER users do not insist upon the delivery of "DRY" coal since FYR-FEEDER handles "WET" coal satisfactorily. Regardless of "rain and snow watered" coal, FYR-FEEDER stokers produce plenty of steam from "WET" coal. FYR-FEEDER was designed to use "WET" coal or dry coal.

AMERICAN COAL BURNER COMPANY

—Engineers—

WRITE FOR CATALOG describing features, operation and installation, or for an engineer to make a survey of your plant.

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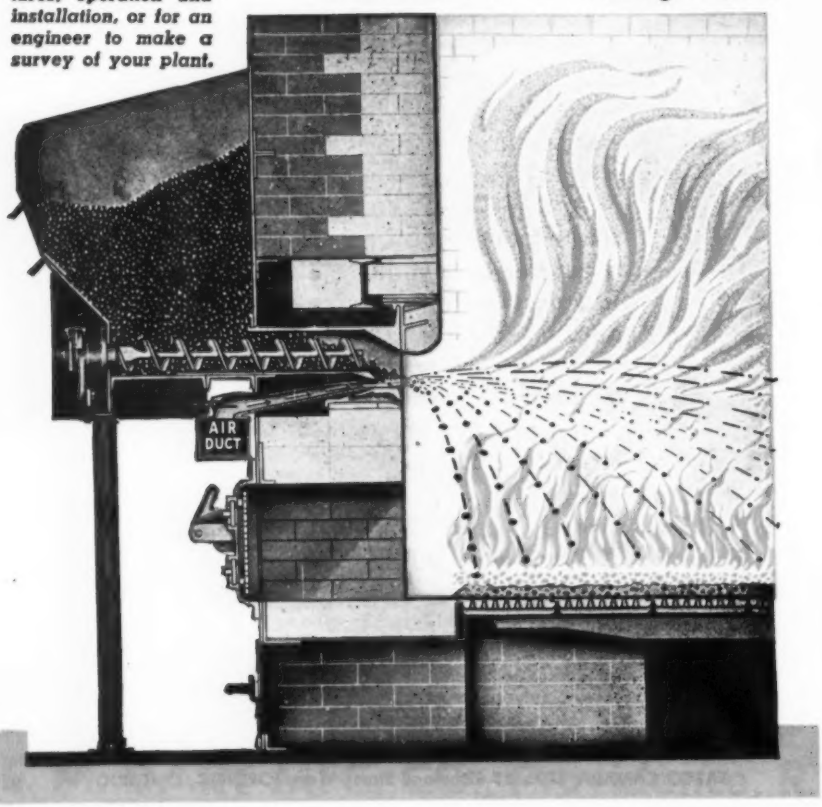
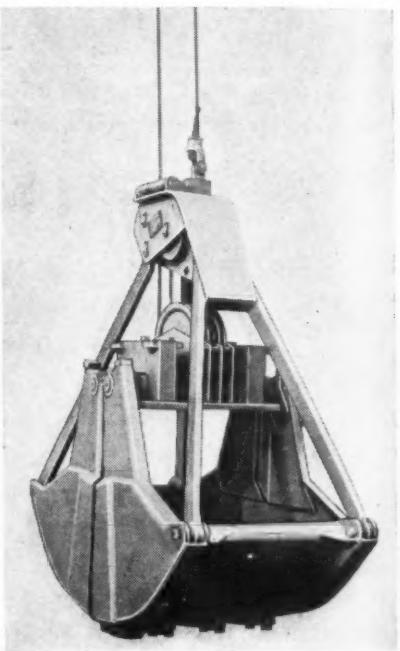


gear bore and shafting surface of sufficient strength to transmit required torque. Also no heat, costly tooling or molds for process. Synthetic is usually recommended as most applications are for operation in presence of lubricant. *Bushings, Inc,* 3442 *W* 11 *Mile Rd, Berkley, Mich.*

Clamshell Bucket

ALL-WELDED CLAMSHELL BUCKET has renewable manganese-steel lip which provides for longer wear than ordinary mild-steel construction. Closing sheaves are equipped with needle bearings which are protected against dirt and moisture by synthetic rubber seal. To



prolong rope life, sheaves are of large diameter and guide sheaves are substituted for guide rollers. General-purpose buckets available from ½- to 2½-yd capacities, rehandling buckets from ½ to 2½ yd, heavy digging from ½ to 1½ yd. *C S Johnson Co, Champaign, Ill.*

Instantaneous Automatic Valve

LUDEMAN DU-AL STEEL VALVES are control valves with a cutoff action which works automatically in breakage or damage to line. Valve operation depends upon balance of pressure upstream and downstream from valve. When downstream pressure falls, because of breakage, leakage or accident, valve instantly and automatically closes. Actual closure is affected by piston action which overcomes spring tension ordinarily holding valve in *open* position. Same piston action may also be

The brute force of line pressures up to 1500 pounds is harnessed with velvet smoothness by KEROTEST Valves. Easy action, positive closing, long life with minimum wear are Kerotest features . . . at work today for war—ready to serve you after Victory.

KEROTEST MANUFACTURING CO.
PITTSBURGH, PENNA.

A FREDERICK STOKER FEATURE
THAT IS GREATLY AIDING THE FUEL CONSERVATION PROGRAM

Active Grate Area —no dead plates!

Reduced tonnage is the rule in plants where Frederick Stokers are installed, and important savings in transportation and labor thereby assured.

The increased grate area of the FREDERICK BURNING END results in a low combustion rate per square foot, and underfeed firing thoroughly burns every bit of coal—fully utilizes the heat-giving gases.

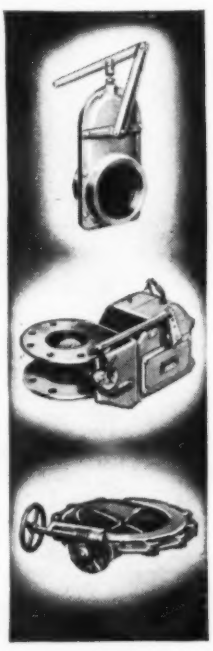
Other Frederick features are fully described in our new Stoker Bulletin. Write for your copy—there's no obligation.

THE Frederick IRON & STEEL CO.
Frederick, Maryland

GET ALL THESE VALVE ADVANTAGES

- ✓ QUICK MOVEMENT
- ✓ ACCURATE CONTROL
- ✓ FULL FLOW
- ✓ TIGHT SHUT-OFF
- ✓ EASY TO INSTALL

Simple—precision-built—dependable control—minimum pressure drop—tight closure against fluid pressure of 15 lbs. Made of any metal for resistance to corrosion, abrasion or heat. For manual or any automatic flow control of gases, liquids or solids.



Slide Valve — 1" to 20" pipe sizes; threaded or flanged; pull handle, lever, hand wheel, chain wheel, or special controls. "Kwikleen" type for dirty air or gases containing solids; easy to clean quickly.

Butterfly Valve — 1" to 48" pipe sizes; hand lever, hand wheel, air diaphragm, hydraulic, electric motor or other controls for wedge tight closure or free rotation of vane.

Wafer Butterfly Valve — 4" to 24" pipe sizes; for narrow space between pipe lines, for any manual or automatic control.

Write for free, new Catalog No. 406

W. S. ROCKWELL COMPANY
48 Church St., New York 7, N. Y.

ROCKWELL VALVES
SLIDE and BUTTERFLY
FOR AIR • GAS • STEAM • LIQUIDS • SOLIDS

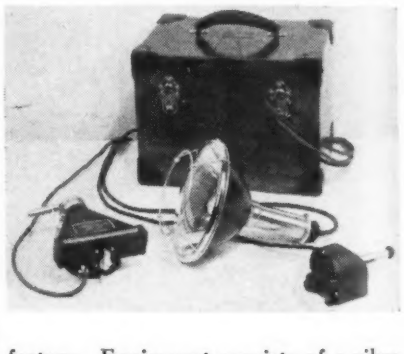
controlled through pilot valves, manually operated at points distant from main valve. Valve may be used in sections where gas vapors are present. *Oscar H Ludeman*, 420 *Lexington Ave, New York* 17, *N. Y.*

Sheave

MAGIC-GRIP SHEAVE locks to shaft in one tightening operation. As its tapered split bushing, which accommodates normal shaft tolerances, is drawn farther into sheave, the bushing, shaft and sheave are locked together simultaneously. Company states that new design permits sheave to be mounted closer to motor, increasing bearing life by reducing shaft overhang. *Allis-Chalmers Mfg Co, Milwaukee* 1, *Wis.*

Balancing Equipment

DAVEY PORTABLE BALANCING EQUIPMENT, for dynamic balancing of machine parts of all sizes in their own bearings or in bearings built for the purpose, is now supplied with an added

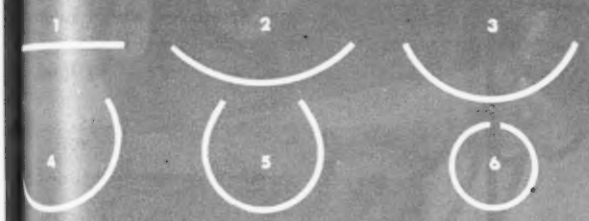


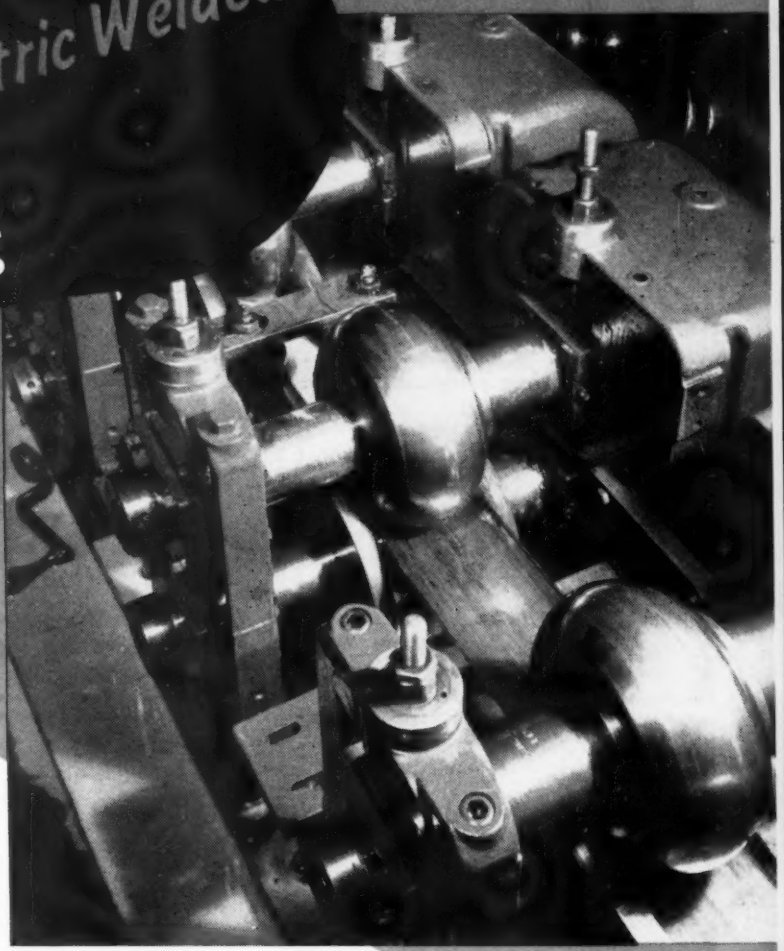
feature. Equipment consists of a vibrometer, which measures vibration amplitude directly, and a stroboscope, which gives a direct visual reading of *high spot* or phase angle. New feature is a remote control switch mounted on vibrometer, which places entire operation in hands of a single operator. Two models are available, complete in portable case with batteries. *Vibroscope Co, 6 E 39th St, New York* 16, *N. Y.*

Electronic Flame Guard

RECENT IMPROVEMENT in manufacturer's Fan-Air automatic mechanical-draft gas burner is the *Transaxil* flame-guard safety pilot. It embodies the electronic principle of flame detection through combination with pilot that is placed in actual contact with flame to be guarded. Principal advantages of *Transaxil* system, according to maker, are the following: (1) unaffected by high temperatures or temperature changes (2) no

No Strain in Forming Talon's Electric Welded Steel Tubing





These forming rolls shape the flat, strip steel into easy-to-fabricate Talon's Electric Welded Steel Tubing.

Flat, accurately trimmed, carefully selected strip steel passes through this series of eleven sets of forming rolls and is formed progressively into round tubing. Properly engineered pass design prevents overstraining and resultant injurious stresses.

Then the material moves into position under the welding unit and the two edges are joined by electric resistance welding. Subsequent operations include bright annealing (when application demands this quality), straightening, cutting to length, EXACTING TESTING, careful inspection, and proper preparation for shipment to your plant.

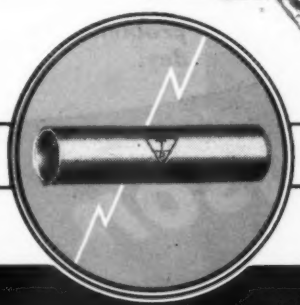
Facts About Easy-to-Fabricate Talon's Tubing

You can fabricate Talon's Tubing by all the standard methods. The section can be changed by beading, flanging, swaging, bending, etc., to meet an endless variety of design requirements.

It can be joined by innumerable methods, either mechanical or welded.

If you plan to use Steel Tubing for your wartime or your peacetime product, you'll find Talon's Tubing easy to fabricate.

Hundreds of miles of Talon's Tubing have been used for the "invasion lines" to carry gasoline, oil, and water to our mechanized forces in the combat areas. Lightweight for ease and speed of placement in the field, great strength and flexibility to withstand the shocks of bombing and shell fire, were the requirements.



PRESSURE **MECHANICAL**

TALON . . INC.

STEEL TUBE DIVISION — OIL CITY, PENNA.

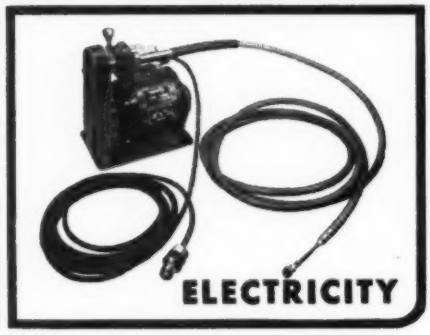
Put "AMBEST" to a long life test on any tough job

"EUREKA"

This UNIVERSAL packing—of long, pliable, anti-friction metallic alloy strands—assures low cost, long life packing protection and easy application on any rod in good condition. "AMBEST"—available for all pressures and temperatures up to 550° F.—is recommended for pumps, compressors, engines, throttles and valve stems. All needs are supplied by one packing when you use "AMBEST."

Write for Working Sample
Send for 36 page catalog.

EUREKA PACKING CO., 294-296 46th St., BROOKLYN 20, N. Y.

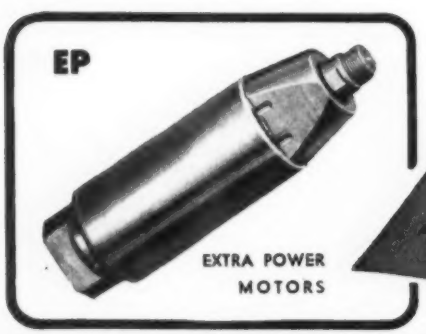


WILSON TUBE CLEANERS

for each of these Power Sources

Wilson Tube Cleaners, with a complete range of cutter heads, brushes, drills and cleaners are available for use with all power sources—air, steam, water and electricity.

Modern tube-cleaners for the problems of today.



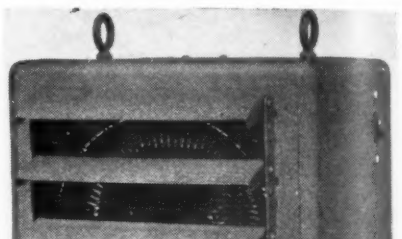
wilson
PIPE AND TUBE CLEANERS EXCLUSIVELY

THOMAS C. WILSON Inc.
21-11 44th AVENUE, LONG ISLAND CITY 1, NEW YORK

carbonizing or oxidizing effects (3) unaffected by wall radiation or surrounding light reflections (4) non-inductive low-heat coefficient and no cooling requirements (5) no metallic contactors or flame rods to adjust or replace (6) extreme sensitivity conditions eliminated (7) no compensators or adjusting accessories (8) flexible and applicable with all kinds of gas fuels. *Lee B Mettler Co, 406 S Main St, Los Angeles, Calif.*

Unit Heaters

TWO NEW MODELS of Electromode electric unit heaters for heating isolated buildings, offices or spaces where intermittent and high efficiency is desired. Installed in any idle space at any level,



they conserve floor space, provide constant air circulation and are easily regulated. Grids are said to attain full heat rapidly at any time. Heaters are available in either portable or suspension models and can be supplied in various capacities, providing from 5112 to 204,900 Btu. *Electric Air Heater Co, 555 S Byrkit St, Mishawaka, Ind.*

Magnetic Separator

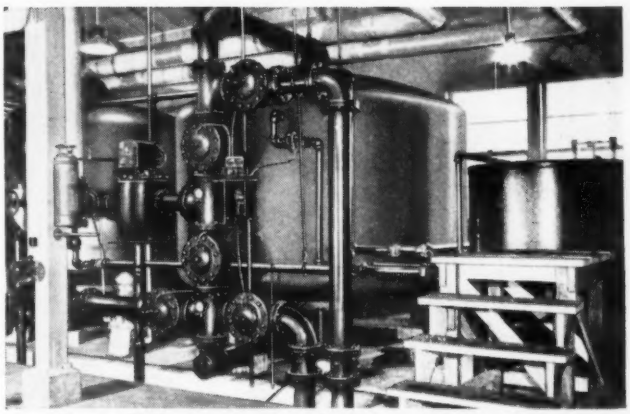
OPERATING ON PRINCIPLE of Ball-Norton underfeed-lift method, *M* magnetic separator is partially inclosed in a welded steel housing for excluding any foreign materials from entering separation process and may be furnished in various sizes and belt widths. Unique patented magnetic field is mounted above lower surface of separating belt. Mixed material is distributed in an even layer by an automatic feeder to a feeder belt, which carries ore or other material into magnetic field where magnetic portion is lifted by magnet power to separating-belt surface. Alternating polarity of magnetic field subjects magnetically attracted portion of material to a violent

10 IMPORTANT REASONS for SPECIFYING GRAVER ZEOLITE WATER SOFTENERS

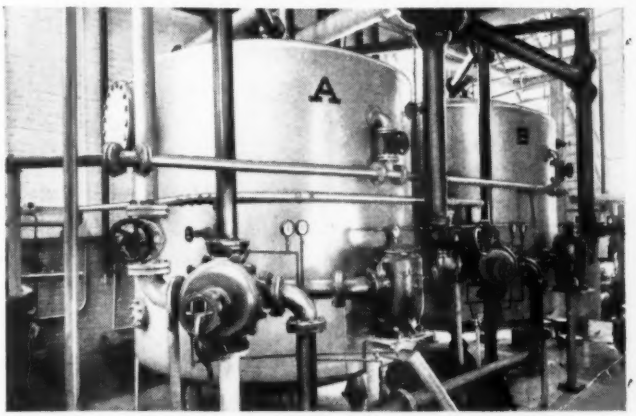
The purchase of a Zeolite Water Softener should be considered carefully, not only from the standpoint of initial cost, but also as regards performance, dependability, and operating economy. When you are ready to make your selection, give careful thought to every angle . . . or better yet, check your requirements against these 10 important advantages of Graver Zeolite Water Softeners:

1. Water of zero hardness (standard soap test) or other predetermined degrees of hardness as desired.
2. Uniform collection and distribution of water, from and to the Zeolite bed, accomplished by means of a reinforced steel plate distributor diaphragm, inset with strainer nozzles on 6″ centers, under the entire bed.
3. Choice of manual, semi-automatic or full automatic operation.
4. Unaffected by flow-rate variations, under the specified limit.
5. Silent, thorough operation with a minimum of attention.
6. Choice of correct Zeolites for most efficient and economical operation.
7. All welded construction; adequate manholes, reinforced openings for piping; adjustable supporting legs.
8. Comparatively low initial cost and small operating cost.
9. Minimum space requirements.
10. Designed, built, installed, or installation supervised, by Graver to meet your specific needs. Complete service and undivided responsibility.

Graver engineers welcome the opportunity to discuss water conditioning questions with you, and invite your correspondence. There's no obligation.



Graver Fully Automatic Zeolite Water Softening Plant.

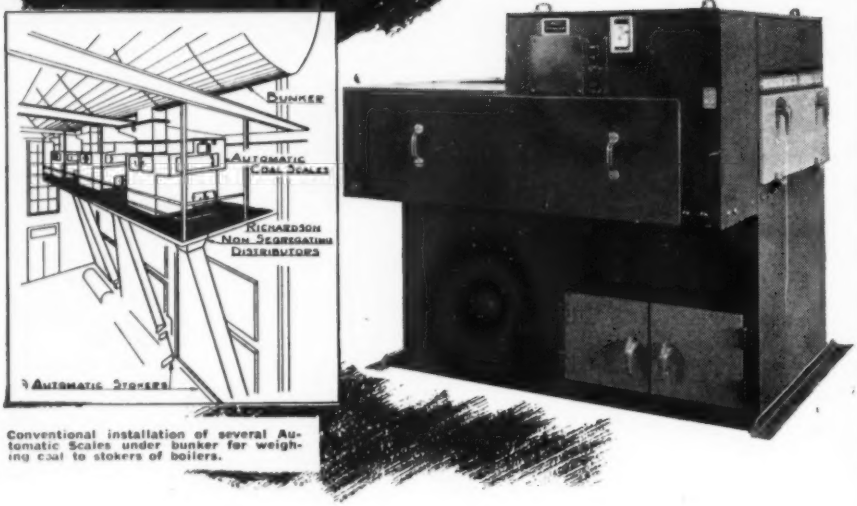


Graver High Capacity Zeolite Water Softening Plant, Double Unit.

GRAVER
WATER CONDITIONING EQUIPMENT

Process Equipment Division of
GRAVER TANK & MFG. CO., INC.
4809-25 Tod Ave., East Chicago, Indiana
NEW YORK CATASAUQUA, PA. CHICAGO TULSA

One OVER EACH BOILER Cuts COAL WASTE



Conventional installation of several Automatic Scales under bunker for weighing coal to stokers of boilers.

Spotting excess coal consumption is speedy and direct with Richardson Automatic Coal Scales. One over each boiler tells when the evaporation rate for any boiler is dropping. Guided by these exact reports, you can go into sure action on a "lame duck" boiler, correct it within a shift, within an hour. In thus maintaining maximum efficiency in all boilers, Richardson Coal Scales make for use of much less coal, save power plants thousands of dollars annually.

In addition, because Richardson Scales do not require weighmen, they release manpower for other work. Models may be equipped to draw coal from distant outlets by means of Richardson elongated conveyors. These save boiler room height, and reduce cost of building.

Complete details of construction and operation of Richardson Coal Scales, including 45 pages of data, diagrams and installation photos, are supplied in Bulletin 1143. Write for a copy.

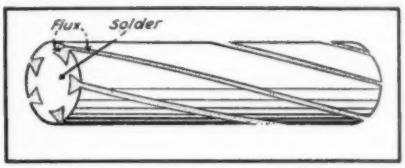
RICHARDSON
SCALE COMPANY, CLIFTON, NEW JERSEY

Atlanta Boston Chicago Philadelphia Omaha Montreal New York
Minneapolis Detroit San Francisco Toronto Wichita Pittsburgh

zigzag rolling movement which releases entrained non-magnetic particles which drop back onto feeder belt and move along to final delivery. Since separating belt runs faster than feeder belt, magnetic material spreads out over a greater area and by active agitation impurities or non-magnetic particles are sifted out, dropping onto feeder belt, and are discharged with non-magnetic material. *Stearns Magnetic Mfg Co, Milwaukee, Wis.*

Wire Solder

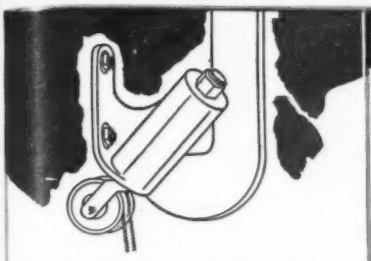
CONTAINING FLUX in longitudinal grooves on surface rather than in conventional core, fluxed-wire solder represents an improvement in design. New material, called Fluxrite, is said to overcome disadvantage of regular cored solders, which supply flux and solder to surface simultaneously. Since flux is outside rather than inside, it liquefies and flows onto work before solder melts. This insures thorough and complete fluxing



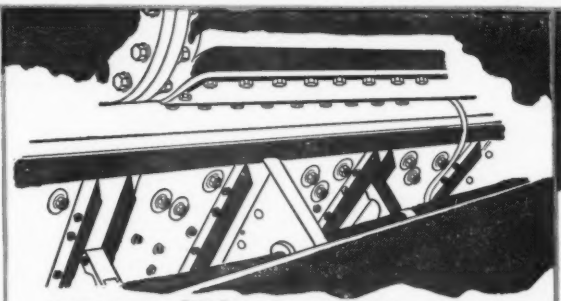
and results in stronger and better solder joins. Solder also is said to guarantee an unbroken flux flow as product has more than one flux-filled groove. Additional advantage claimed is that it is always visible and therefore can be quickly and readily checked. Product containing special flux comes in same diameters as regular cored solder. It is available in red stripe and green stripe for identification. *National Lead Co, 111 Broadway, New York, N. Y.*

Hot-Gas Generating Furnace

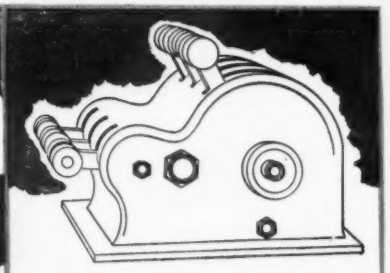
HOT GAS, a mixture of combustion and air products or recirculated gases, is produced at almost any desired temperature by direct oil-fired hot-gas generating furnace. Agitair furnaces for spray towers, food baking and drying, etc, where material being processed is not affected by contact with hot gases. Recirculating Agitair furnaces are also available for superheaters or heat exchangers. Control is fully automatic. Constant discharge temperatures are maintained by modulated controls and a reversing burner-control motor. Furnace will operate down to 25% of full capacity. Draft regulator insures complete combustion and prevents excessive lining temperature. Hot gases gen-



THROTTLE EQUALIZER MECHANISM fastened with Elastic Stop Nuts keeps throttle settings the same, even when the hull is distorted by heavy seas.



ENGINE BEDS. PT boats are a blasting mass of power. Besides, stresses and strains make the hulls weave. So, to hold the engines tight and secure against vibration and other forces, they are fastened down with Elastic Stop Nuts.



ENGINE ROOM SIGNALS and engine controls center in this unit held firm and secure with Elastic Stop Nuts.

Courtesy of Higgins Industries

GRIPPING TIGHT ON THE BATTLING COCKLESHELLS

They're swift. They're light. They're crammed with 4,000 throbbing horsepower that drives them, fighting like demons, through giant seas at breakneck pace.

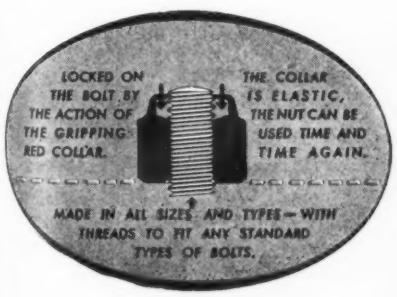
Naturally they take an awful beating.

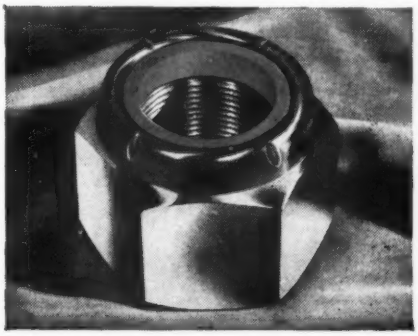
Under such shock and vibration only the surest fastenings will hold. That's why throughout Higgins Boats you'll see the famous red collar that marks Elastic Stop Nuts.

These nuts hold fast in the face of the worst vibration. This is accomplished by the elastic collar built in the head of the nut. This collar grips the bolt — presses itself between the bolt threads and holds tight. The nut can't wiggle. It can't turn. It can't shake loose.

These nuts will work wonders in peacetime uses. They'll make products safer, stronger and longer-lasting. They'll keep production equipment working with fewer inspections, take-ups and replacements.

Get the facts from our engineers. They'll gladly tell you about Elastic Stop Nuts and sit down with you to help work out any fastening problem you have.


LOCKED ON THE BOLT BY THE ACTION OF THE GRIPPING RED COLLAR.
THE COLLAR IS ELASTIC, THE NUT CAN BE USED TIME AND TIME AGAIN.
MADE IN ALL SIZES AND TYPES — WITH THREADS TO FIT ANY STANDARD TYPES OF BOLTS.



ELASTIC STOP NUT CORPORATION

Gentlemen:

Torpedo boats must be built to stand terrific punishment — not only from heavy seas, but from vibration of engines, machine guns and depth charges. Precious time in maintenance and a greater sense of security are gained by the use of Elastic Stop Nuts at all vital points. Weight is also at a premium in PT's as in aircraft and prohibits the use of more cumbersome and less positive locking methods.

Yours very truly,

Ted Sprague

PROJECT ENGINEER, HIGGINS INDUSTRIES, INC.

ESNA

TRADE MARK OF

ELASTIC STOP NUT CORPORATION OF AMERICA

ELASTIC STOP NUTS

Lock fast to make things last

UNION, NEW JERSEY AND LINCOLN, NEBRASKA

MERCOID

"DA" CONTROLS FOR PRESSURE OR TEMPERATURE IN EXPLOSION-PROOF HOUSING

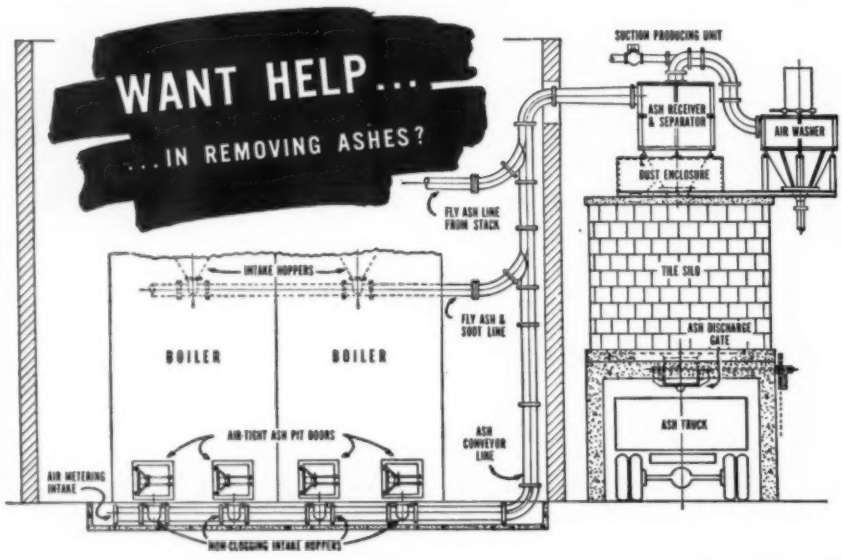
Mercoid "DA" Controls are particularly suited for the accurate and dependable service required on many essential industrial applications.

The outside double adjustment feature permits setting of the control without removing the explosion-proof case cover. The accurately calibrated dial and pointers indicating the operating range, are plainly visible through the shatter-proof glass cover. The direct reading eliminates guesswork.

A heavy Bourdon tube actuates the mercury switch. The Mercoid corrosion-proof mercury switch assures positive make and break in the electrical circuit during years of continuous performance.

For complete data see Mercoid catalog No. 600. A copy will be sent upon request.

THE MERCOID CORPORATION • 4205 W. BELMONT AVE. • CHICAGO, ILL.



Get the help you need by installing a Beaumont Birch "Vac-Veyor" pneumatic ash handling system. Labor is saved; cleanliness effected. System time-tested. Low first cost. Low operating cost. Installation as flexible as running a pipe line. Minimum critical materials required. Two sizes, two types—for delivering ashes either dry or damp.

For details — write!

BEAUMONT BIRCH COMPANY
1505 RACE STREET PHILADELPHIA, PA.

DESIGNERS • MANUFACTURERS • ERECTORS OF COAL AND ASH HANDLING SYSTEMS

erated are without smoke or odor except sulphur odor in fuel. Viscosity valve system insures constant feed of Bunker C or No. 5 fuel oil. Adjustable fresh-air-intake dampers control amount of air admitted between inner and outer furnace shells and also regulate amount of draft in firebox. *Air Devices, Inc*, 17 *E 42nd St, New York* 17, *N. Y.*

Heating Tanks

PORTABLE MODEL 20 consists of a well-insulated heating tank equipped with electric heaters, a motor and pump for circulating the oil, thermostats for maintaining oil temperature within cer-

tain limits, electric controls and valves. Unit is mounted on casters. Stationary units are manufactured in a large size range, with or without mechanical agitation. *Youngstown Miller Co, Sandusky, Ohio.*

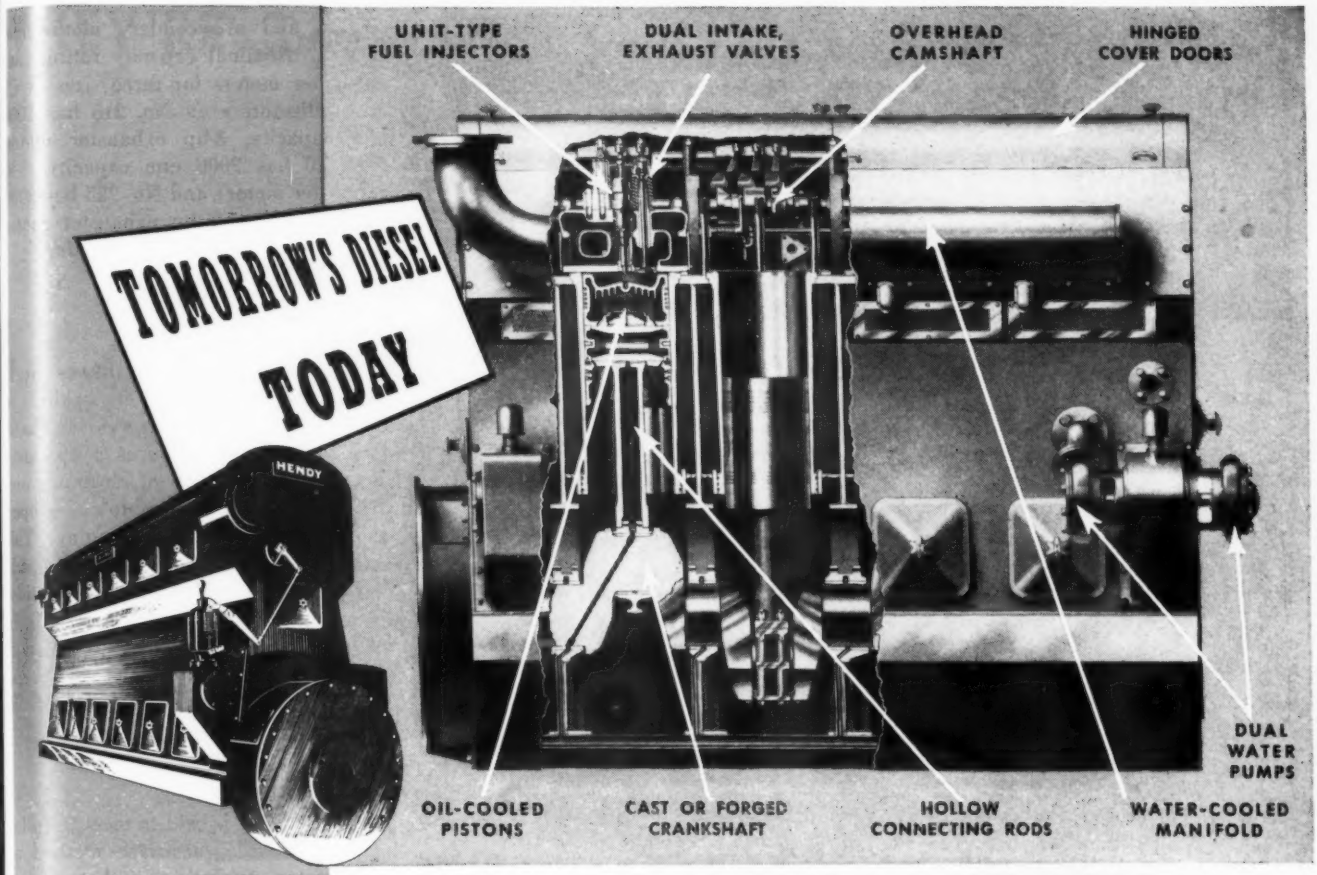
Strap Wrench

TOOL FOR BETTER HANDLING and protection of polished nickel and chrome pipe and tubing. It is made with strong I-beam handle and solid head, all in one

piece, with a hang-up hole in the end. Webbing strap is removed for replacement by pushing out pin held by spring clips. Ridgid strap wrench is made in two sizes: No. 2, capacity ⅛ to 2 in., 17-in. strap; No. 5, 1 to 5 in., 30-in. strap. *Ridge Tool Co, Elyria, Ohio.*

Unit Dust Collector

CK UNIT DUST COLLECTOR for smaller air-volume dust-control problems where a self-contained unit is indicated. Unit consists of a preliminary centrifugal



GENERAL SPECIFICATIONS
SERIES "50"
Bore—12"; Stroke—15"
350 to 600 hp.
RATED POWER
at 450 rpm.
75 hp. per cylinder
Available with reduction gears and power take-off to meet special conditions.

Write for complete data on the Hendy Series 50 Diesel Engine

Only HENDY DIESELS
Combine all these features...

For the first time, 22 important design and construction features are combined in a single engine—the Hendy Diesel. Each makes a substantial contribution to low-cost operation or longer engine life. More than a half century of power-plant experience — plus expanded facilities — gives Hendy unusual ability for volume production of these new Diesels.

In addition to the features illustrated, Hendy Diesels have positive, full-automatic lubrication...controlled cooling system ...mechanical or hydraulic governing...centrifugally cast, babbitt-lined, steel-backed bearings...and centralized controls. Before you invest in any Diesel—be sure to look at Hendy's. For simplicity—long life—for modern design—look to Hendy.

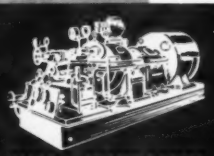
JOSHUA HENDY Division
JOSHUA HENDY IRON WORKS

SUNNYVALE, CALIFORNIA

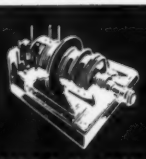
ESTABLISHED 1856

HENDY

BRANCH OFFICES: Boston • Buffalo • Chicago • Cincinnati • Cleveland • Detroit • New York • Philadelphia • Pittsburgh • San Francisco • St. Louis • Washington • Los Angeles

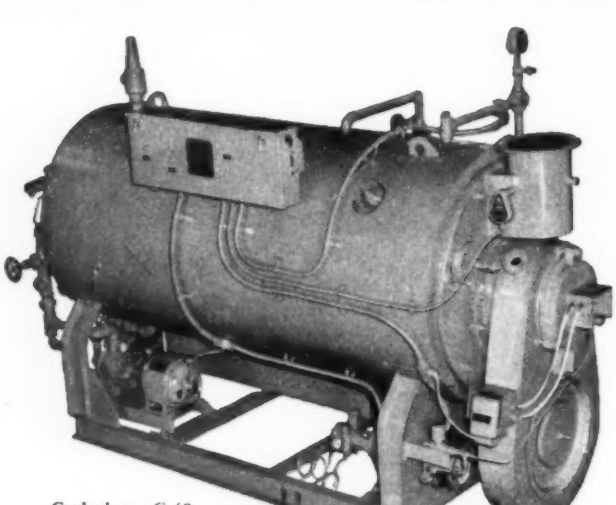

TURBO-GENERATORS

REDUCTION GEARS


STEAM TURBINES

DIESEL ENGINES

DOLLAR EFFICIENCY—work done per dollar spent—measures the value of steam generation



Cyclotherm C-40

This fully automatic 40 horsepower steam generator unit complete with feed water tank and feed pump is used widely by the United States Government. Like all Cyclotherms, this unit which is completely self-contained is adaptable to processing, power or heating.

Hundreds of Cyclotherms of varied horsepower have proved their dependability and economy under a wide range of wartime conditions. They are found highly efficient at low operating cost for their exclusive principles of combustion get unusual steam value per unit of fuel consumed.

They are designed and built to give years of trouble-free service with a minimum of attention. For owners who wish a long-lived and efficient steam generator with low operating and maintenance cost, a Cyclotherm has definite advantages.

Cyclotherms are manufactured in units from 10 to 300 horsepower. They are oil or gas fired. Some units are available now and deliveries are being made as rapidly as the press of Government orders permits.

If you are planning replacements, our engineers will be glad to consult with you on any problem you may have. Write or call for additional information or any business or technical data you may wish.

CYCLOTHERM
STEAM GENERATOR

AMES IRON WORKS
OSWEGO . . NEW YORK . . BOX 202

section and a secondary cloth-screen section. Nominal capacity ratings and exhauster motors for three sizes of CK unit collectors are: No. 215 has 1000-cfm capacity, 3-hp exhauster motor; No. 220 has 2000 cfm capacity, 5-hp exhauster motor; and No. 223 has 3000-cfm capacity, 7½-hp exhauster motor. *Pangborn Corp, Hagerstown, Md.*

Lubricating Nozzle

FOR LUBRICATING HEAVY GEARS or in chemical processes and other kinds of service, nozzle with long-wearing, hardened-steel orifice produces a flat-spray pattern. Construction of clean-out needle makes it unnecessary to cease operation when orifice needs cleaning. This feature, plus the fact that the nozzle may be built of many materials besides the steel generally used, makes it highly adaptable. Various capacities and spray angles are available. *Spraying Systems Co., 4021-5 W Lake St, Chicago 24, Ill.*

Phosphate Comparator

LA MOTTE UNIT is said to meet need for a rapid, simple, accurate method of boiler-water analysis so that proper phosphate treatment may be applied. Phosphate comparator employs two reagents, only one of which is in solution form. Concentration range covers 0 to 100 ppm PO_4. Higher readings may be made by dilution principle. Outfit comes complete with standard LaMotte block comparator. *LaMotte Chemical Co, Towson, Baltimore, Md.*

Internal Insulation

INSIDLINE, AN INTERNAL INSULATION, enables carbon-steel pipe to stand up under pressure at temperatures above 1000 F. By holding the temperature of the pipe itself to 650 F or below, *creep* does not occur and pipe may be operated indefinitely at usual stress allowances. In addition to saving expense of building special pipe from scarce alloy steels, Insidline is claimed to simplify pressure-piping design by reducing number of expansion joints, bends and other expansion provisions. *Baldwin-Hill Co, 501 Klagg Ave, Trenton, N. J.*

Twin Pumping Unit

PUMPS ARE 90 GPM CAPACITY each for pressures up to 100 psi and are mounted on a cast-iron base. A single 1800-rpm motor serves as a driver through a reduction gearing. Pump operation is controlled by new twin clutches. Pumps

THEY'RE 3-WAY COST-CUTTERS

FOR DOUBLE EXTRA HEAVY

EXTRA HEAVY

STANDARD

PIPE LINES

Watson-Stillman Forged Steel Socket Welding Fittings offer two economical advantages in lower material cost and lower welding cost. Their efficiency and long-wearing qualities are also important factors in keeping down maintenance and operating costs.

W-S Socket Welding Fittings are easy to install — just slip over pipe and weld. No special fixtures are needed to hold or line up joint — the deep socket supports the pipe. Tack welding is unnecessary. Fittings have same inside diameter as pipe — assuring smooth unrestricted flow.

Bulletin A-3 gives complete specifications and engineering data for all Watson-Stillman fittings, including a complete line of screw end forged steel fittings. The Watson-Stillman Co., Roselle, N. J.

WATSON-STILLMAN

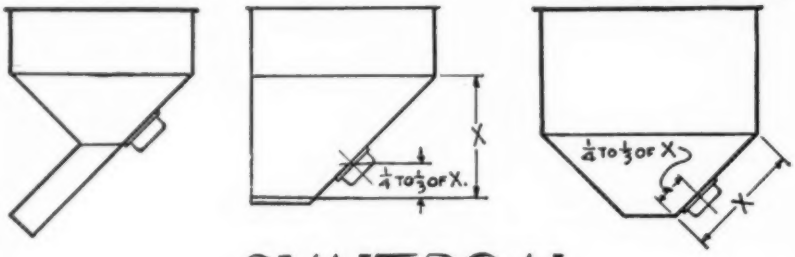
Distributor Products Division

DESIGNERS AND MANUFACTURERS OF FORGED STEEL FITTINGS, VALVES, AND HYDRAULIC EQUIPMENT

5365

DO YOU HAVE *"Constipated"* BINS?

Like these?

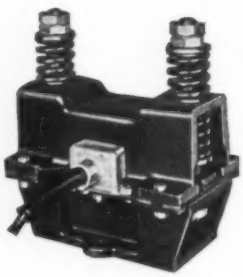


SYNTRON

"Pulsating Magnet"

ELECTRIC VIBRATORS

MAKE STUBBORN, WET COAL FLOW FREELY THRU BINS, BUNKERS & CHUTES



Eliminate Arching and Plugging

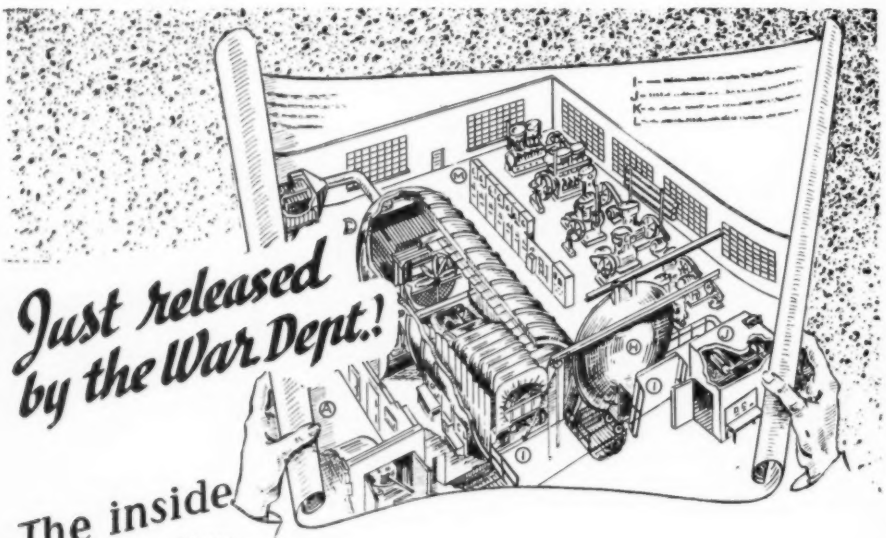
3600 powerful "Electronic-Controlled" vibrations per minute break down arching and plugging—assure a steady, free flow of coal, to pulverizers, stokers, etc.

8 models - - from a little 4 lb. size up to big 500 lb. sizes, with capacities of from 1 cu. ft. hoppers up to big 100 ton bins.

Operate from 110 volts, 220 volts or 440 volt AC current.

Write us about your problem

SYNTRON CO., 492 Lexington, Homer City, Pa.



Just released by the War Dept.!

The inside data on the great new all-weather laboratory using

Get your complimentary copy now of this diagram (twice letter size, with complete description, plus photographs) showing one of the most remarkable air conditioning and refrigeration jobs ever built. Write

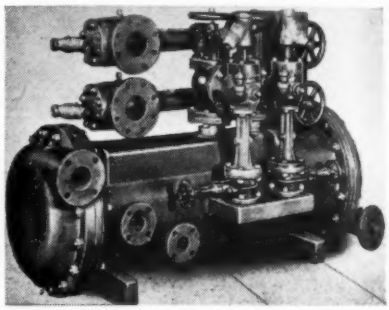
FRICK COMPANY, Waynesboro, Penna.

FRICK TRADE MARK Refrigeration

may be operated singly or together. Chief advantage of unit is that it provides double capacity to take care of temporary peak requirements, or that it permits handling of two different liquids without contamination. Pumps operate on *bucket design* principle and are furnished in three constructions: unlined, with removable liners for handling corrosive or abrasive liquids, or with steam-jacketed heads for pumping highly viscous liquids or materials that are solid at room temperatures. *Blackmer Pump Co, Grand Rapids, Mich.*

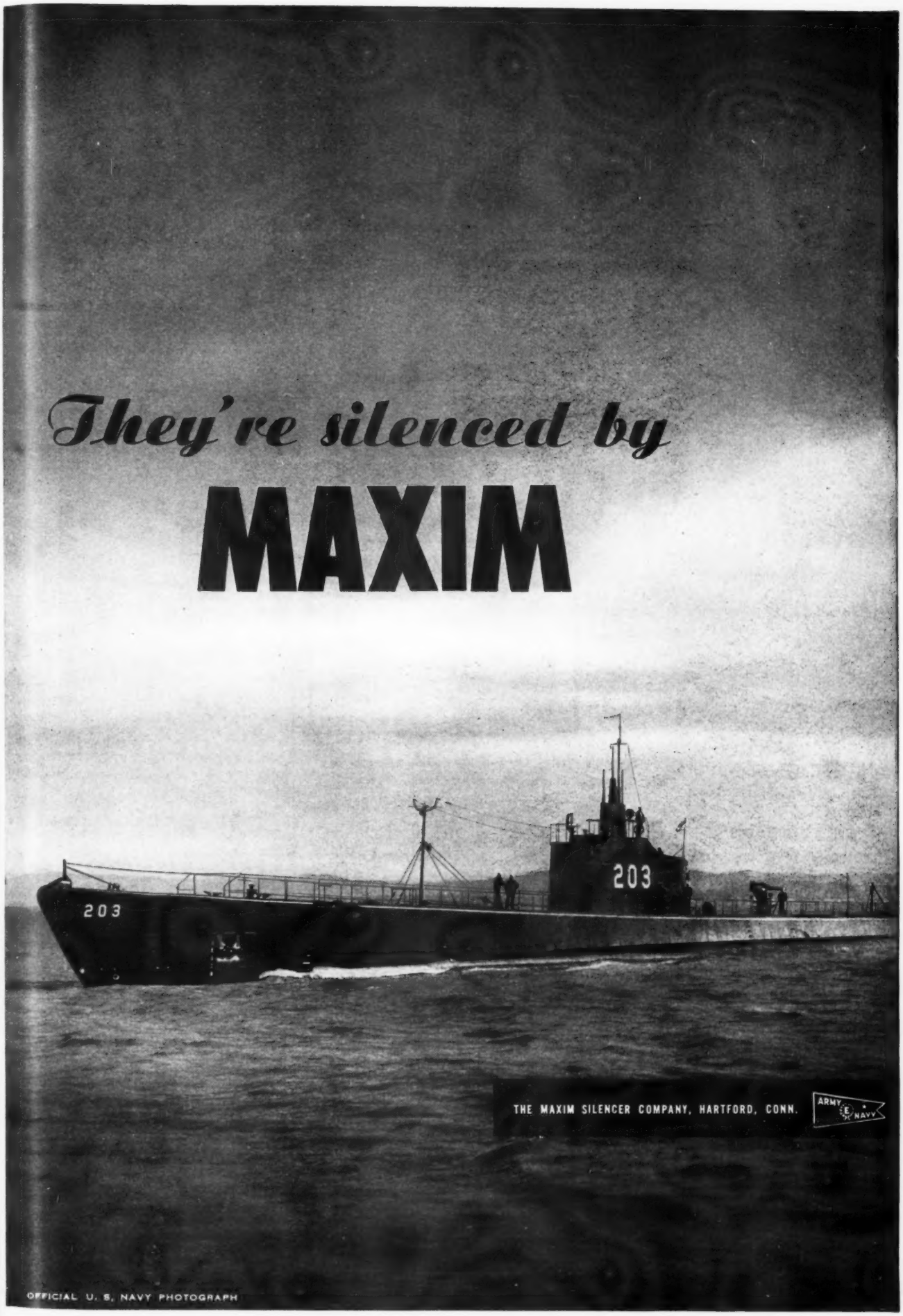
Marine Ejector

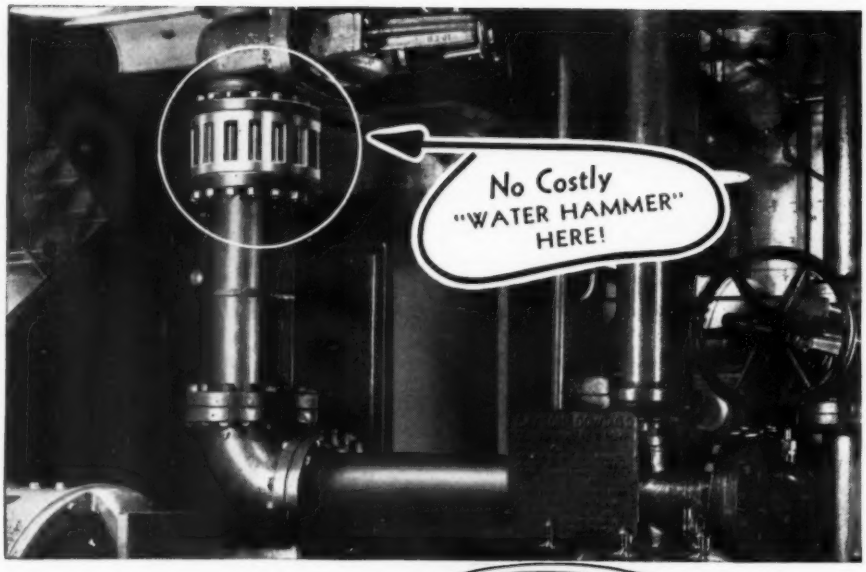
ELLIOTT MARINE STEAM-JET EJECTOR is a twin 2-stage unit with combined inter- and after-surface-condensers. It can be bolted direct to bulkhead with all pipe connections accessible on one side. All four ejector stages are provided with isolating valves so that any stage can be removed without interfering with operation of the others. All valves are accessible. Each ejector stage is equipped with a single nozzle and each has its own self-cleaning steam strainer with removable screen and blowoff connection. Each stage is also equipped with a sentinel relief valve for protection if operator should turn on steam with isolating valves closed. After condenser has extra surface to condense gland leakoff steam from propulsion turbine, thus eliminating a separate condenser for this purpose. *Elliott Co, Jeannette, Pa.*



Bushing Cement

ORIGINALLY DESIGNED to cement transformer leads into porcelain bushing, Dolph's No. 16-A bushing cement, because of its unusual properties, is adapted as a permanent sealer for cable joints, boxes, instruments, etc. This black compound's adhesion to metal and porcelain is excellent. Unlike similar compounds, it has a low coefficient of contraction. It becomes extremely hard, thus standing the strain of rapid temperature changes. Its oilproof and


They're silenced by
MAXIM
203
203
THE MAXIM SILENCER COMPANY, HARTFORD, CONN.
ARMY
NAVY
OFFICIAL U. S. NAVY PHOTOGRAPH



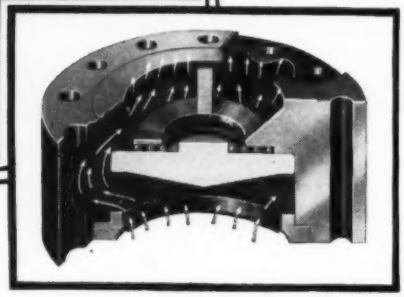
A 10"-300 lb. Williams-Hager Flanged Silent Check Valve in the Merchandise Mart, Chicago.

Dependable Protection with

WILLIAMS-HAGER

FLANGED SILENT

CHECK VALVES



TIME-PROVED INSTALLATIONS

Specified as standard equipment for:

Public Utilities
Water Works
Industrials
Oil Refineries
Paper Mills · Hotels
Chemical Works
Office Buildings
Public Buildings
Breweries
Steamship Lines, etc.

Successfully used to prevent Pump Failure, Line Breakage due to "Water Hammer" on Water, Steam, Hydraulic, Chemical or Oil Lines!

Heavy duty service records upwards of 17 years without removal from lines . . . Williams-Hager Flanged Silent Check Valves are built to meet the exacting requirements of any end use. No webs to restrict or hamper the flow of liquids . . . the free-floating valve will operate normally and efficiently in *any* position.

Dependably constructed in sizes from 1" to 20" inclusive, from iron, semi-steel, bronze, cast steel, stainless steel or monel . . . pressure resistant to 6,000 pounds.

Write today for interesting folder on "Water Hammer—Cause, Effect and Control in Piping Systems."

THE WILLIAMS GAUGE COMPANY

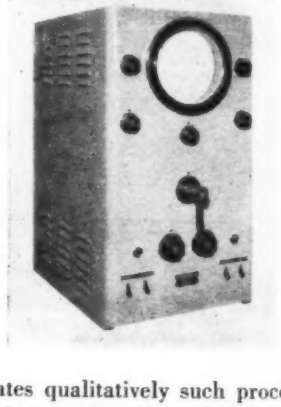
Pump Valves . . . Water Gauges . . . Gauge Cocks . . . Pump Governors . . . Steam Traps Feed Water Regulators . . . Water Columns

2055 PENNSYLVANIA AVENUE · PITTSBURGH (12), PA.

waterproof qualities prevent oil leakage and water seepage. Cement is homogeneous and retains its uniformity during melting, thereby eliminating caking during melting process. Material does not foam when heated. Cement melting point is 265 F (ball and ring) with pouring temperature of 400 F. *Dept* 41, *John C Dolph Co*, 168 *Emmett St, Newark* 5, *N. J.*

Winding-Insulation Tester

ELECTRONIC WINDING-INSULATION TESTER tests faulty insulation and winding dissymmetries in motors, generators, coils and transformers. Employing principle of balance and comparison, instrument simultaneously tests turn-to-turn coil-to-coil and coil-to-ground insulation. It



simulates qualitatively such procedures as resistance impedance-balance turn-balance and complete high-potential tests with one voltage application. Tester consists of a repeating surge-voltage generator, cathode-ray oscilloscope and synchronously driven switching equipment, all inclosed in one steel cabinet for bench mounting. *General Electric Co, Schenectady, N. Y.*

Wire-Rope Clamp

MANUFACTURER RECENTLY ADDED new sizes to line. Heretofore, Safe-Line clamps were made in only nine sizes, but they are now available in 13, ranging from $\frac{1}{8}$ to $\frac{3}{4}$ in. *Safe-Line Clamp div, National Production Co*, 4561 *St. Jean Ave, Detroit, Mich.*

Arc-Welding Electrode Holder

HELIUM-SHIELDED arc-welding electrode holder for manual operation, with either helium or argon gas, welds light metals, such as magnesium and its alloys, which require precise heat control and protection from oxidizing effect of air. It also welds other hard-to-weld metals, such as aluminum and stainless steel. Lightweight holder consists of a Texto-

—a newspaper editorial,
January 14, 1944
MILITARY SECRET
FROM 130 B. C.
The jet propulsion plane apparently is a rocket plane without the fire and smoke. The invention, no doubt, will be credited to modern day science and ingenuity, altho the greatest wonder about jet propulsion is that mankind has let the idea kick around for so long without putting it to use.
If you want a picture of the first jet propulsion motor, flip the pages of the dictionary to the word aeolipile. The aeolipile was the first steam engine, and it was jet propulsion, pure and simple. Hero of Alexandria, a Greek mathematician and physicist, about whom little is known except that he probably lived about 130 B. C., invented or gave the first account of the aeolipile.
It is a metal basin with a cover, standing on a tripod. Hollow tubes lead up from the basin or boiler to a metal sphere, which is mounted so that it can revolve. Two jets protrude from opposite sides of this sphere, with their tips turned at a tangent to the sphere, like the arms of a swastika. Put some water in the basin, build a fire beneath it, and the steam whistles out of the jets, spinning the ball.
Men have learned to do a lot of things with steam since Hero's time, but it took them more than 2,000 years to realize that Hero had something in jet propulsion.
READING-PRATT & CADY

GLAD TO SEND YOU A RICH WOODCUT PRINT SHOWING THE ORIGINAL USE OF JET PROPULSION BY HERO OF ALEXANDRIA, 130 B.C.

The announcement of the new jet-propelled mystery war plane—unspeakably fast and powerful—just gives more proof to those old-timers who stick to the idea that there is nothing new under the sun.

A Chicago newspaper in an editorial late in January traced the idea to Hero of Alexandria and dated its first use as 130 B.C.—in what is often called the original steam engine.

READING-PRATT & CADY's research ran across the story about five years ago—and a very early drawing of the steam engine. We located an old-time woodcut craftsman and asked him to reproduce the ancient sketch.

The 5¼" x 5½" prints were so interesting and rich in their early simplicity that we offered to send a copy, mounted on mat board ready for framing, to any who would like one.

Today, because of the nation-wide interest in jet propulsion, we are repeating the offer. Please make your request on the letterhead of your company and address our offices at Reading, Pennsylvania.

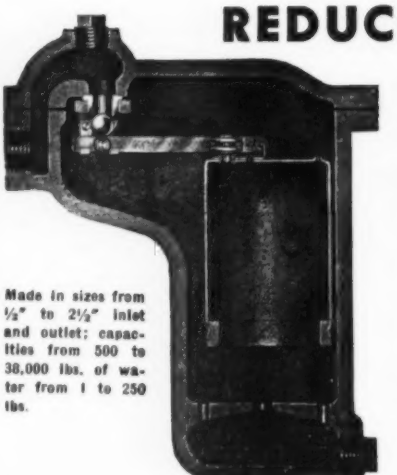
READING-PRATT & CADY

MANUFACTURERS OF
READING CAST STEEL VALVES AND FITTINGS
PRATT & CADY BRASS AND IRON VALVES
D'ESTE VALVE AND ENGINEERING SPECIALTIES

Reading, Pa., Atlanta, Boston, Chicago, Denver, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, San Francisco

A DIVISION OF **AMERICAN CHAIN & CABLE COMPANY, Inc.** BRIDGEPORT • CONNECTICUT

REDUCE THE LOAD



Made in sizes from ½" to 2½" inlet and outlet; capacities from 500 to 38,000 lbs. of water from 1 to 250 lbs.

on already over taxed MANPOWER . . . *with* CRYER STEAM TRAPS

Shortage of manpower need be no handicap to efficient plant performance insofar as steam lines are concerned when CRYER TRAPS are used.

Designed to permit complete discharge of air before condensate and built of materials which assure long-life and minimum attention, the CRYER can be depended on to function dependably and operate satisfactorily on even the most troublesome lines. Air binding, slow venting and dribbling troubles which would ordinarily keep overtaxed maintenance crew "on the alert" are eliminated with CRYERS on the job.

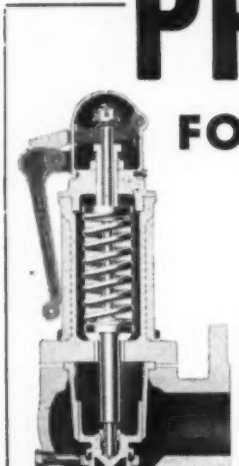
WHY CRYER STEAM TRAPS ARE DEPENDABLE

. . . they are non-binding, all air being discharged before condensate through valve at top.
. . . they are positive-acting, a free turning ball valve providing correct seating.
. . . they are quick-venting, air being discharged rapidly, through mechanically controlled valve regardless of temperature.
. . . they are readily accessible and easily cleaned.
. . . they have ample capacity for the job they have to do.

We carry repair parts for J-M Ball Steam Trap

CRYER TRAP AND VALVE CO. INC.
Manufacturers of Steam Specialties for over 40 years.
366 MADISON AVE. NEW YORK, N. Y.

ASSURED PROTECTION FOR PRESSURE SYSTEMS



Top-guided—high capacity—precision-built—the Lonergan "WTN-EL" Steel Safety Valve provides the highest type of protection for your boilers and other pressure systems.

The "WTN" Series is more than just one valve—it is a whole family of related designs and constructions for steam, air, gases or liquid service.

Model "WTN-EL"
Steel Safety Valve with stainless steel trim
FOR PRESSURES
450 lbs. / sq. in. "Type 1" for temp. up to 650°F.; "Type 2" up to 750°F.

Vital pressure systems must be guarded—use *dependable* LONERGAN safety and relief valves.

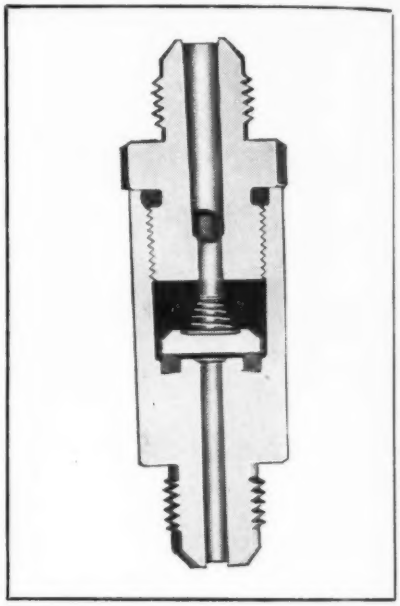
Write for Bulletin 501-A

"SINCE 1872"

Lonergan

J. E. LONERGAN COMPANY, 2nd & RACE STS., PHILA. 6, PA.
SAFETY VALVES • RELIEF VALVES • PRESSURE GAUGES • SPECIALTIES

lite handle, steel gas nozzle and a copper electrode clamp fitted with a tool-steel spring collet. Holder may be laid down without arcing, as handle, gas nozzle and electrode clamp are fully insulated. Button for controlling gas-supply valve is located on holder handle. Tapered friction joint between electrode clamp assembly and handle facilitates rapid change of electrode size without tools or threaded connections. Electrodes may be left in their clamps and substitution made by removing one assembly from handle and slipping on another. *General Electric Co, Schenectady, N. Y.*

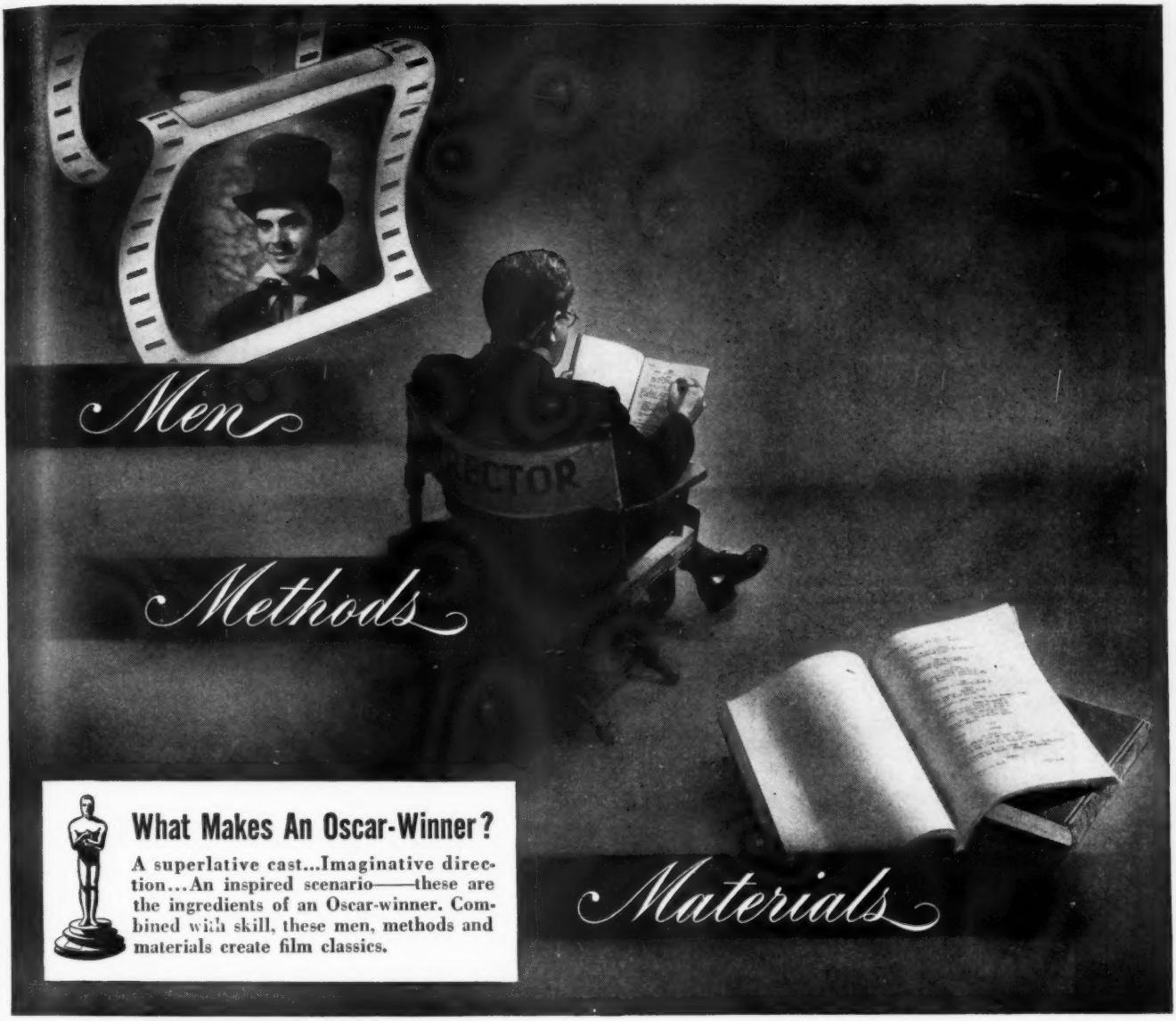


Check Valve

A SCREW MACHINE PRODUCT of only three parts, check valve uses no hardened steel and requires no grinding or honing equipment. It not only conserves critical war materials and machines, according to maker, but effects a cost saving. *Electrol, Inc, Kingston, N. Y.*

Gas Analyser

INSTRUMENT DETERMINES percentages of O_2, CO_2, CO and H_2 simultaneously in combustion processes and continuously records the amounts on a single chart. Different colors and numbers on chart show the four registrations (one for each gas). Complete analyzer operates directly from ac supply line. Recorder may be located at any required distance from sampling point, and instrument can be furnished with contacts for operating warning signals or to actuate various control circuits. It accomplishes analysis by direct comparison of thermal conductivity of sample with that of a reference gas, or by comparison


Men
Methods
Materials
What Makes An Oscar-Winner?
A superlative cast...Imaginative direction...An inspired scenario——these are the ingredients of an Oscar-winner. Combined with skill, these men, methods and materials create film classics.

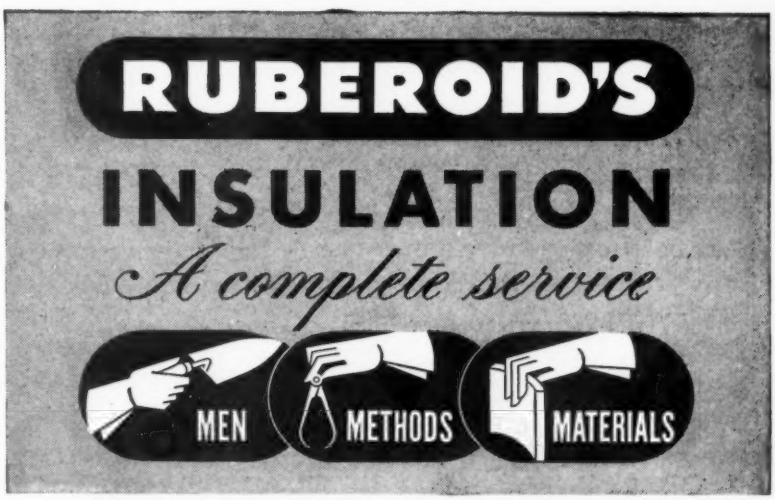
You get insulation efficiency the same way

● All the elements *properly coordinated*—men, methods and materials. This is the RUBEROID way to assure maximum service from industrial insulation.

MEN . . . The right men are all-important. Skilled mechanics in the nationwide organization of Ruberoid Approved Applicators handle the jobs. These men know their business. They've licked the most difficult insulation problems.

METHODS . . . Each installation is "tailor-made" to meet the individual job. Ruberoid engineers are not wedded to any one method. You get the benefit of broad experience with all possible methods of application.

MATERIALS . . . The right insulation material to meet your specific temperature control problem. The Ruberoid insulation line has no "gaps" in it from 0° to 1900° F.



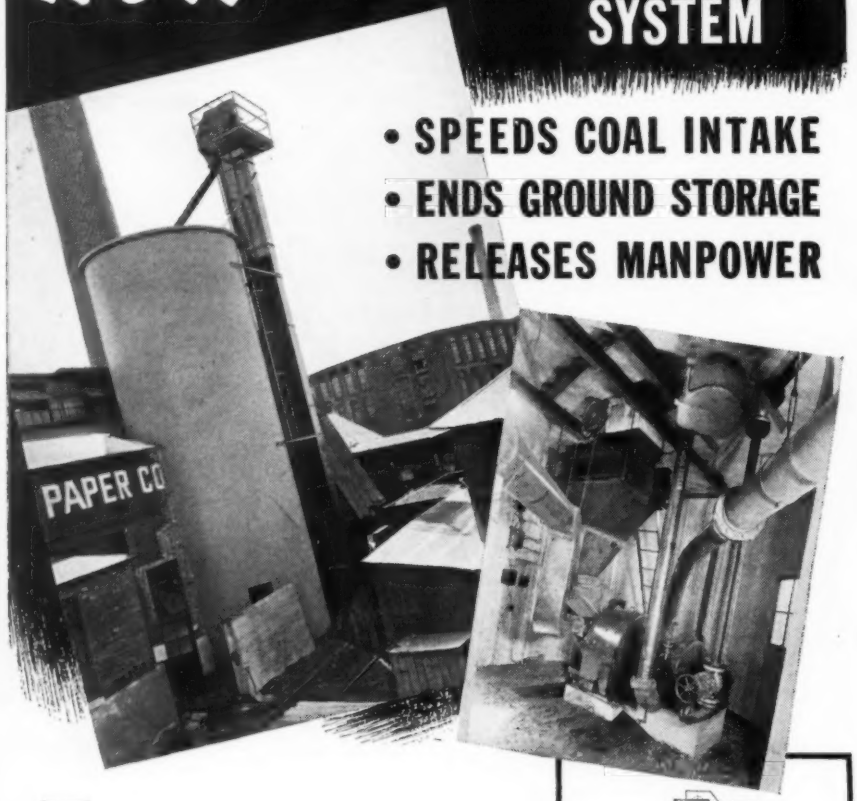
Write for Ruberoid Insulation Guide and technical data.

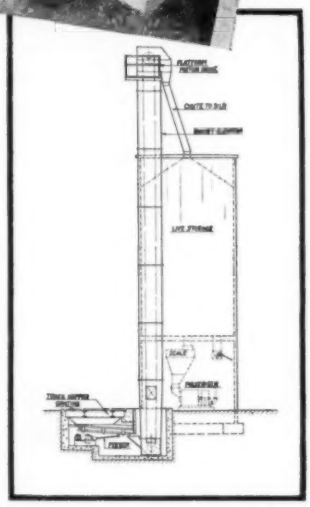
The RUBEROID Co., *Executive Offices*, 500 Fifth Avenue, New York 18, N. Y.

ASPHALT AND ASBESTOS BUILDING MATERIALS

HOW A G-W COAL HANDLING SYSTEM

- SPEEDS COAL INTAKE
- ENDS GROUND STORAGE
- RELEASES MANPOWER





THIS complete coal handling installation for the Foster Paper Co. of Utica, N. Y., licked a shortage of space, eased a manpower situation, and thus led to expanded production.

Coal received direct from cars through a track hopper is fed to the elevator and raised to the overhead bin. It is then drawn to a scale, pulverized and discharged automatically into boilers. Completely mechanized, this Gifford-Wood system has a capacity of 50 tons per hour, eliminates ground storage and 90% of previous handling labor. The silo-protected coal doesn't absorb moisture or freeze. With the silo next to the boiler house, pulverizer located under live storage bin, a highly efficient setup is achieved.

Take advantage of Gifford-Wood's long engineering experience. Ask for a plan and proposal for a space and labor-saving system designed for your needs.

GIFFORD-WOOD CO.

FOUNDED 1814

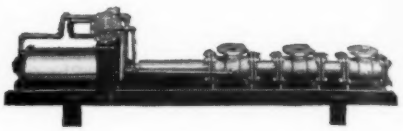
New York: 420 Lexington Ave. HUDSON, N. Y. Chicago: 565 W. Washington Street

Ash Spouts - Barge Unloading - Bins - Boiler House Equipment - Buckets - Bunkers - Carriers - Chutes - Conveyors - Crushers - Elevators - Feeders - Gates - Ground Storage Systems - Hoists - Hoppers - Infra-Red Drying Systems - Screens - Silo Storage Plants - Tanks - Weigh Larries - 5372

of thermal conductivity of sample before and after chemical absorption or combustion. Results are recorded directly without any corrections or interpolation. Recorder is automatically connected to circuit of each analysis cell in succession. Duration of each connection is one minute. *Cambridge Instrument Co, 3732 Grand Central Terminal, New York, N. Y.*

Water-Supply Interconnector

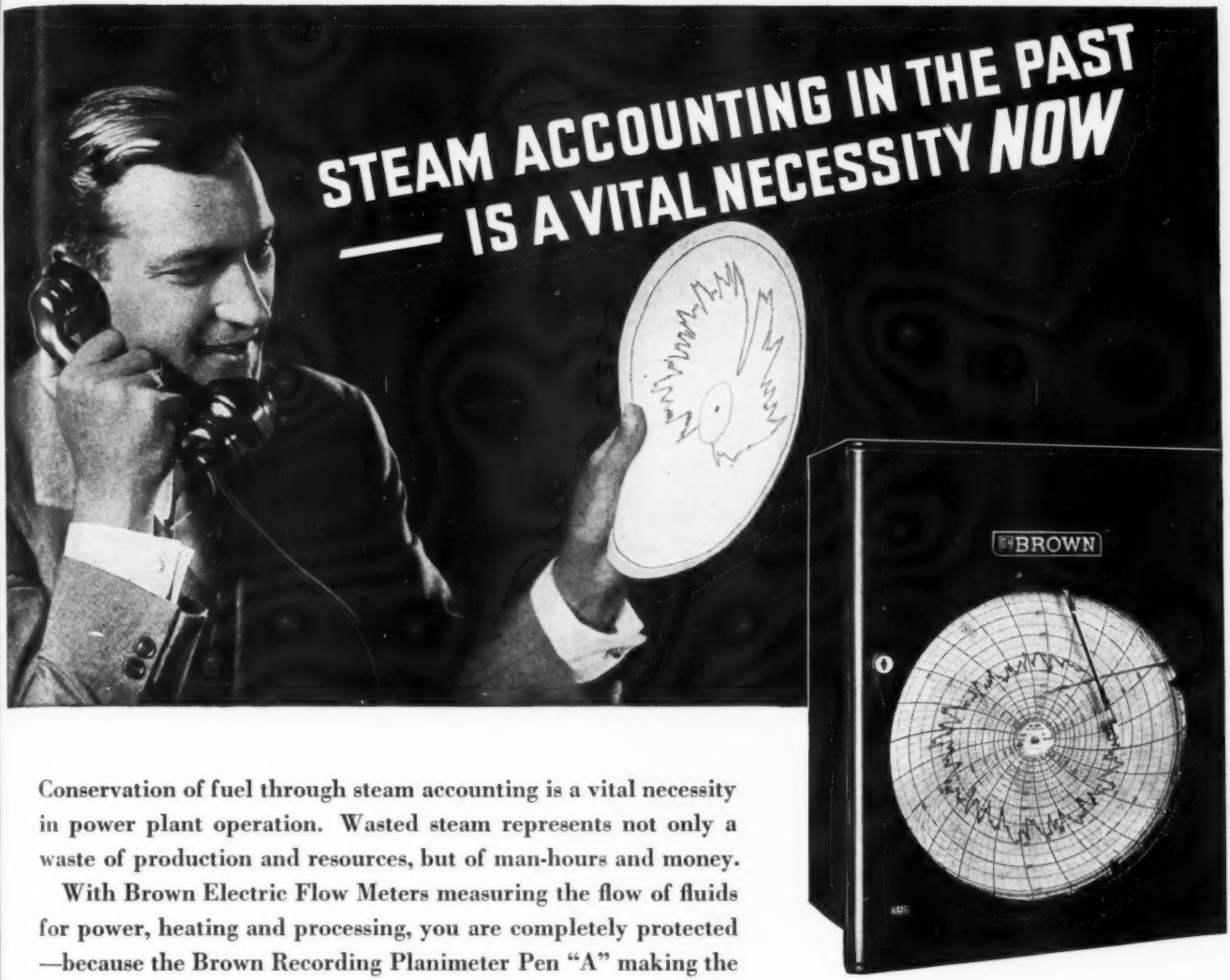
SURE-SHIFT INTERCONNECTOR is a hydraulic valving mechanism designed to deliver water from either of two inlets to a common outlet. Choice of inlets is automatically made according to hydrostatic pressure prevailing in inlet customarily used. Should this pressure drop below a predetermined point, usually



about 20 psi, water supply is automatically shifted to standby source. Upon resumption of pressure in the customary water source, supply connection shifts back to original position. Automatic operation of interconnector is of value to industries which require uninterrupted water source. It shifts over in approximately 15 sec, depending on water pressures, without manual attention. This protects compressors, condensers and equipment requiring uninterrupted supply of cooling water. It is equally useful for a standby source of feedwater. *Industrial Interconnector Co, 2150 Niagara St, Buffalo 7, N. Y.*

Metallic Flux

MOGUL FLUX has a lower melting temperature than soft silver solder on initial heats and, when activated, works on slightly higher temperatures than 60/40 solder. This cuts down warpage, material-hardness changes and stresses. It is said to work faster than ordinary flux and it is compounded of finely ground pure metals, balanced to attain high-tensile strength and surface adherence. Its low-surface tension permits tinning of close tolerances, such as thread fits, without bubbling out. Many metal combinations may be treated this way, such as aluminum and copper, cast iron, steel, etc. Available in 1-lb sealed-metal cans only. *Metallizing Co of America, 1330 W Congress St, Chicago.*



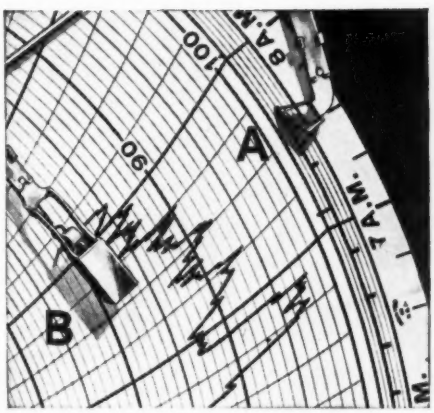
Conservation of fuel through steam accounting is a vital necessity in power plant operation. Wasted steam represents not only a waste of production and resources, but of man-hours and money.

With Brown Electric Flow Meters measuring the flow of fluids for power, heating and processing, you are completely protected —because the Brown Recording Planimeter Pen "A" making the marginal record shown on the chart pictured supplies the proof that a definite number of pounds of steam, gallons of water, cubic feet of gas or barrels of oil were delivered, utilized or wasted.

This outstanding feature of Brown Electric Flow Meters is of the greatest value in cost accounting of steam production and distribution.

In addition, Brown Electric Flow Meters enable the operators to maintain the most efficient boiler operation—thus effecting substantial fuel savings.

For details, write for Catalog 2008. THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Company*, Wayne and Roberts Avenues, Philadelphia 44, Pennsylvania. Offices in all principal cities. 119 Peter Street, Toronto, Canada—Wadsworth Road, Perivale, Middlesex, England—Nybrokajen 7, Stockholm, Sweden.



Automatic planimeter pen record "A" shows steam flow in volume units. Record line "B" shows rate of flow.

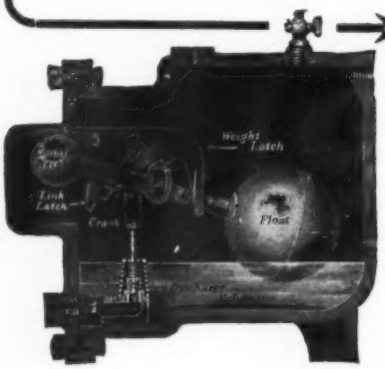
BROWN FLOW METERS

. . . MINNEAPOLIS - HONEYWELL CONTROL SYSTEMS . . .

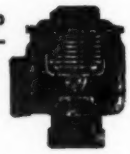
To Measure and Control is to Economize

NICHOLSON TRAPS ARE BEING USED BY

Representative Firms in Every Major Line of American Industry



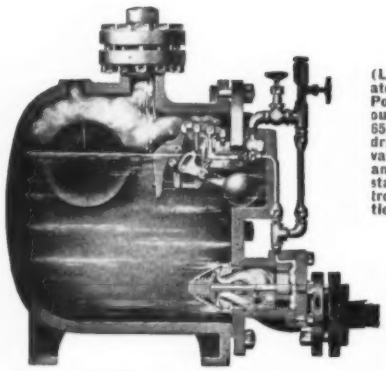
There's a Nicholson trap for almost every use — all with superior features.



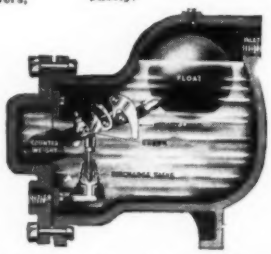
(Left) Weight-Operated Steam Trap for pressures to 1500 lbs. at 1000-degree maximum temperature.

(Right) Compressed Air Trap for automatic drainage of water and oil from air tanks, receivers, etc.

(Above) Type AU Thermostatic Trap, one of five types. Enormous water and air discharging capacity.



(Left) Piston-Operated Steam Trap. Positive, instantaneous, for pressures to 650 lbs. Non-wire drawing discharge valve. Valves, seats and working parts of stainless steel for trouble-free operation.



Write for Catalog No. 941

W. H. NICHOLSON & CO.

125 OREGON ST., WILKES-BARRE, PA.

Here is a 2 cu. yd. Sauerman Scraper with 260 ft. operating radius, reclaiming 75 tons of coal an hour from 25,000-ton storage pile.

PEAK EFFICIENCY *plus* SAFETY!

in Storing and Reclaiming Coal

Every well managed plant demands that combination. Nothing less will do—for today coal is fighting this war too.

A Sauerman Power Drag Scraper System is the correct answer. A one-man machine that stores and reclaims for only a few cents per ton handled—that utilizes and conserves all available space, piling higher than is otherwise possible—that operates simply and rapidly, avoiding the dirt and dust of heavier equipment.

SAFE—Because it builds, layer upon layer, a homogeneous, steep-edged pile. There is no segregation of lumps and fines; no voids in the pile to cause spontaneous combustion.

Sauerman Power Scrapers are low in first cost as well as operating cost. Two types, with manually shifted or power shifted tail blocks, adjustable to areas of any size.

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Swain Will Tour Carolina Plants

Editor Phil Swain of POWER is scheduled to address the Engineers' Club of Western North Carolina on the evening of April 17, at the George Vanderbilt Hotel, Asheville, N. C. His subject will be: "New Horizons for Engineers—New Materials, New Machines, New Methods, New Viewpoints, Better Engineering Education."

Mr Swain will then spend about ten days visiting engineers and plants along the route to Raleigh, N. C., probably passing through Canton, Greenville (S. C.), Spartanburg (S. C.), Gastonia, Charlotte, Kannapolis, Salisbury, Lexington, Winston-Salem, Greensboro, Chapel Hill, Durham, Raleigh—then to New York without stop.

While this great industrial region is familiar ground through previous editorial tours, readers in the Carolinas are invited to suggest visits of timely engineering interest along the proposed route.

Citation of Electric Light and Power Industry

Award of a special citation by the Chas A Coffin Foundation to America's electric light and power industry was announced on March 12 by Gerard Swope, chairman, board of trustees for the foundation and president, General Electric Co. Quoting in part from the citation, Mr Swope said:

"Faced with unprecedented demands, the electric light and power industry has met every war production requirement without delay and without impairment of its peacetime services to the public. This achievement merits the appreciation not only of American industry but of the entire nation.

"No other country in the world has as large a supply of electric power for industry, either in total or per workman, or so abundant a supply of light and power for the home.

"This appreciation will be echoed by the men at the front who are using the products made possible by the neverfailing supply of electric power, and recognized by the people at home, who in these difficult days still have the comforts and conveniences that an adequate supply of electricity gives them and, in sharp contrast with almost anything else they are using, at unit prices lower than they have ever been in the past."

Krug Praises Utilities For War Job

"No segment of our war economy can boast of a better job" than the electric power industry, Director J A Krug, Office of War Utilities, notified the second annual meeting of the Council of Electric Operating Companies at Chicago in March.

In a letter to Council President Tom P Walker, Krug added:

"I hope that you will pass on to the utility representatives present my sincere appreciation of the excellent and wholehearted cooperation which we have had from your

FROM WAR PLANT TO BEACHHEAD

COFFIN—*Steam Turbine* CENTRIFUGAL PUMPS

Help Deliver the Goods

The part assigned to Coffin Pumps is like that of the ground crew of the air force—not sensational but extremely important.

That they are playing their part well is due to the same characteristics that made them successful before the war.

1. SOUND ENGINEERING DESIGN

Small—Compact—Easy to Handle. Both pump impeller and steam turbine are mounted on a single shaft, without couplings. Two precision type ball bearings support the entire rotating element.

2. STANDARDIZATION

All wearing parts are made to precision gauge tolerances. All parts are one hundred percent interchangeable. This is rigidly maintained.

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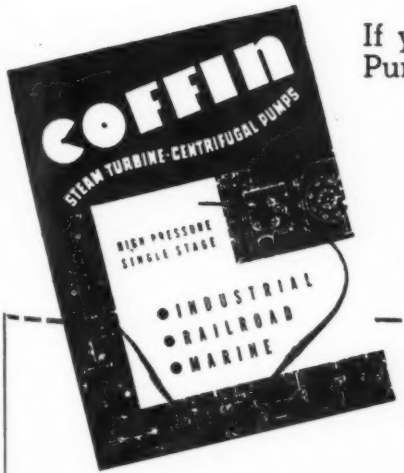
Since both pump and turbine elements are designed and selected to function as a single unit, maximum efficiency and low steam consumption is achieved.



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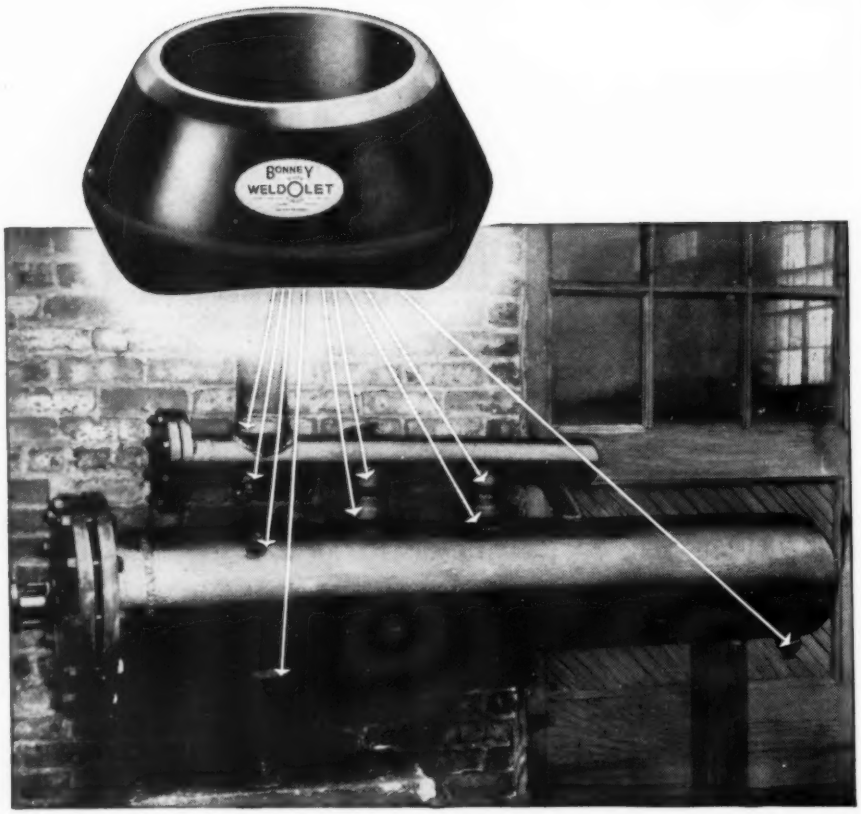

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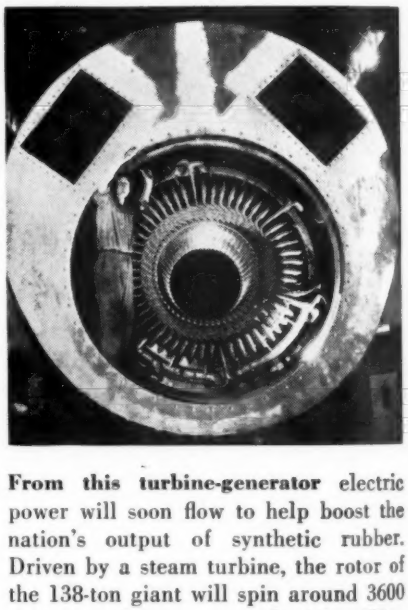
organization and from all of its member companies individually.

"The critical war production year of 1943 is behind us with all of its rapidly increasing power needs safely met. I am confident that the power facilities now in place, supplemented by the limited number of new plants still under construction, will adequately provide for all essential power requirements in 1944 and 1945. No segment of our war economy can boast of a better job and, at the same time, this achievement was accomplished with the minimum use of materials so necessary in the direct conduct of the war."

Allis-Chalmers announces that **T C Knudsen** is manager and chief engineer of the new texrope dept, handling the line of multiple V-belts and sheaves; and that **A D Robertson** is asst mgr of Norwood, Ohio, works, handling all but the larger sized motors. **W H Feldmann** has been elected president and genl mgr, **Electric Machinery Mfg Co; Silas McClure,** president since 1921, becomes chairman, board of directors. **Meehanite Metal Corp** grants manufacturing rights for their castings to **Indian Hume Pipe Co,** Wadala, Bombay, India.

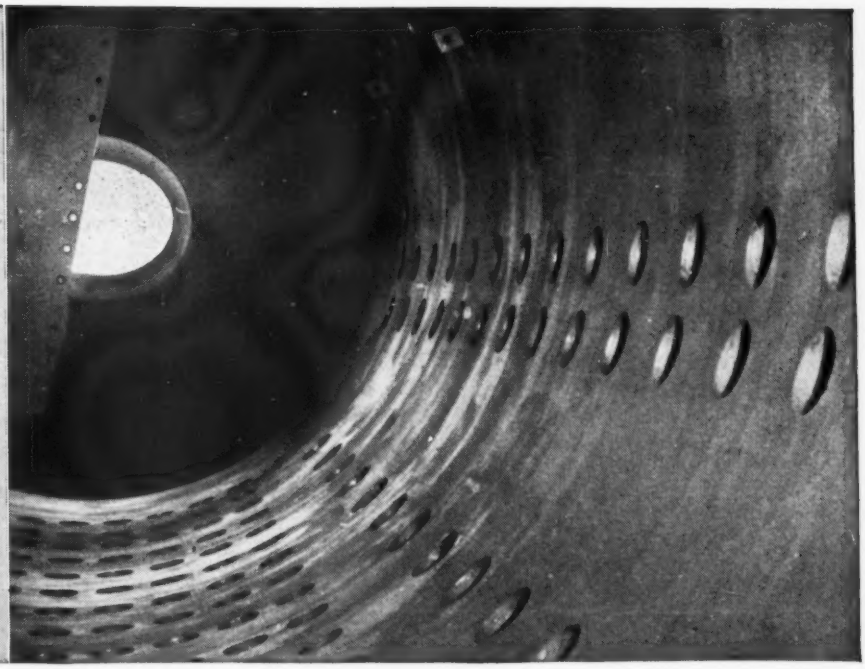
Frame for 138-Ton Giant



From this turbine-generator electric power will soon flow to help boost the nation's output of synthetic rubber. Driven by a steam turbine, the rotor of the 138-ton giant will spin around 3600 times a minute to supply 35 million watts of electric power. Generator is cooled by hydrogen, which is blown by fans within the circular frame shown above. Westinghouse is building it.

The Army Air Forces is offering for sale raw and fabricated materials, standard parts, motors, hardware, fabrics, precision tools, equipment and other **surplus stocks.** Companies who wish their names placed on the active bidders list are invited to write Army Air Forces, Materiel Command, Midcentral Procurement District, 111 W Jackson Blvd, Chicago 4, Ill., Attention: Redistribution & Salvage Section.

Scrap?... Reduce Pressure? ...No, APEXIORIZE!



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Looks, fortunately, are often deceiving. Boilers that appear to be ready for the scrap pile or for operation at reduced pressure, have often been restored to good operating condition by APEXIOR. If they can pass inspection and a hydrostatic test, this long-lasting, corrosion-resistant, scale-resistant covering will "peg" that condition for more years of good performance.

APEXIOR seals up the pores and joints. It is applied with a hand brush or power coater after cleaning down to bare metal. One application lasts 2 to 3 years, and is easily renewed when worn too thin for protection. APEXIOR takes the wear . . . not the metal.

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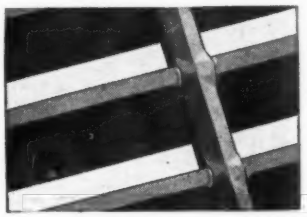

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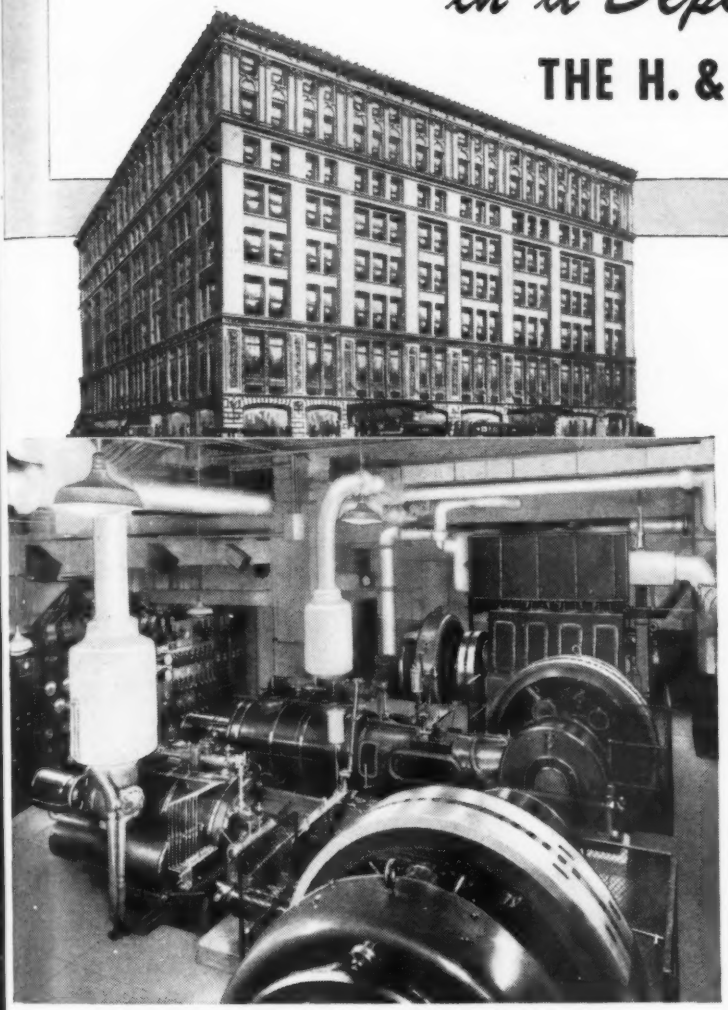

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WHEN the modern building program of this distinguished old department store was started in 1903, the far-sighted management installed four 100-kw. Skinner Steam Engine-Generators to produce electric power. Additions to the store and continued increase in electrical loads made it necessary eventually to replace these small units with four larger steam engines of the more modern Skinner "Universal Unaflow" type.

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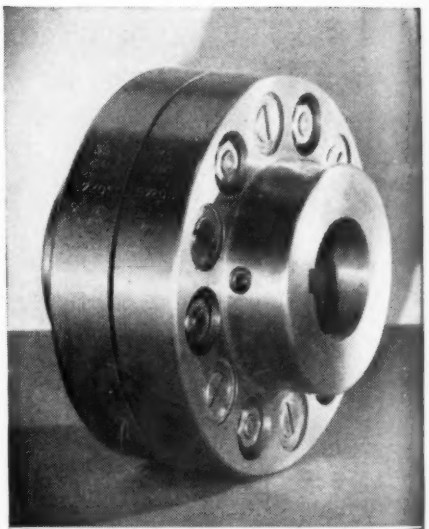

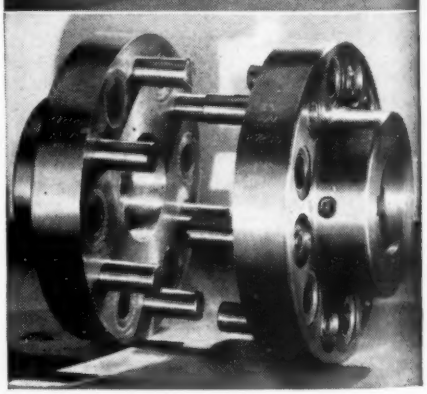

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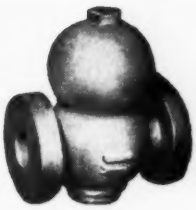

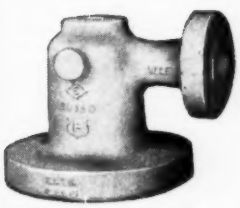

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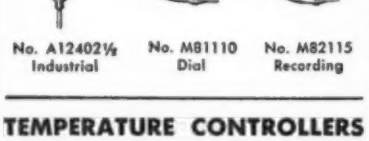

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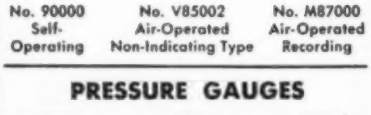

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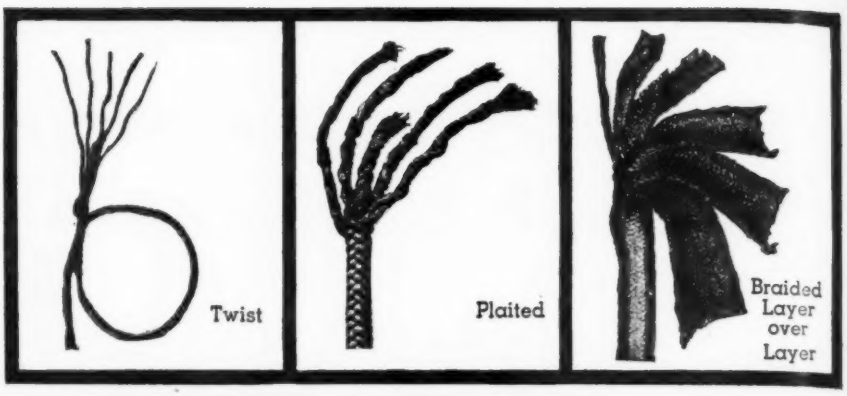

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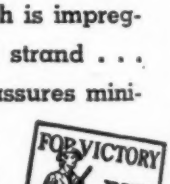

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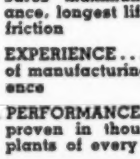

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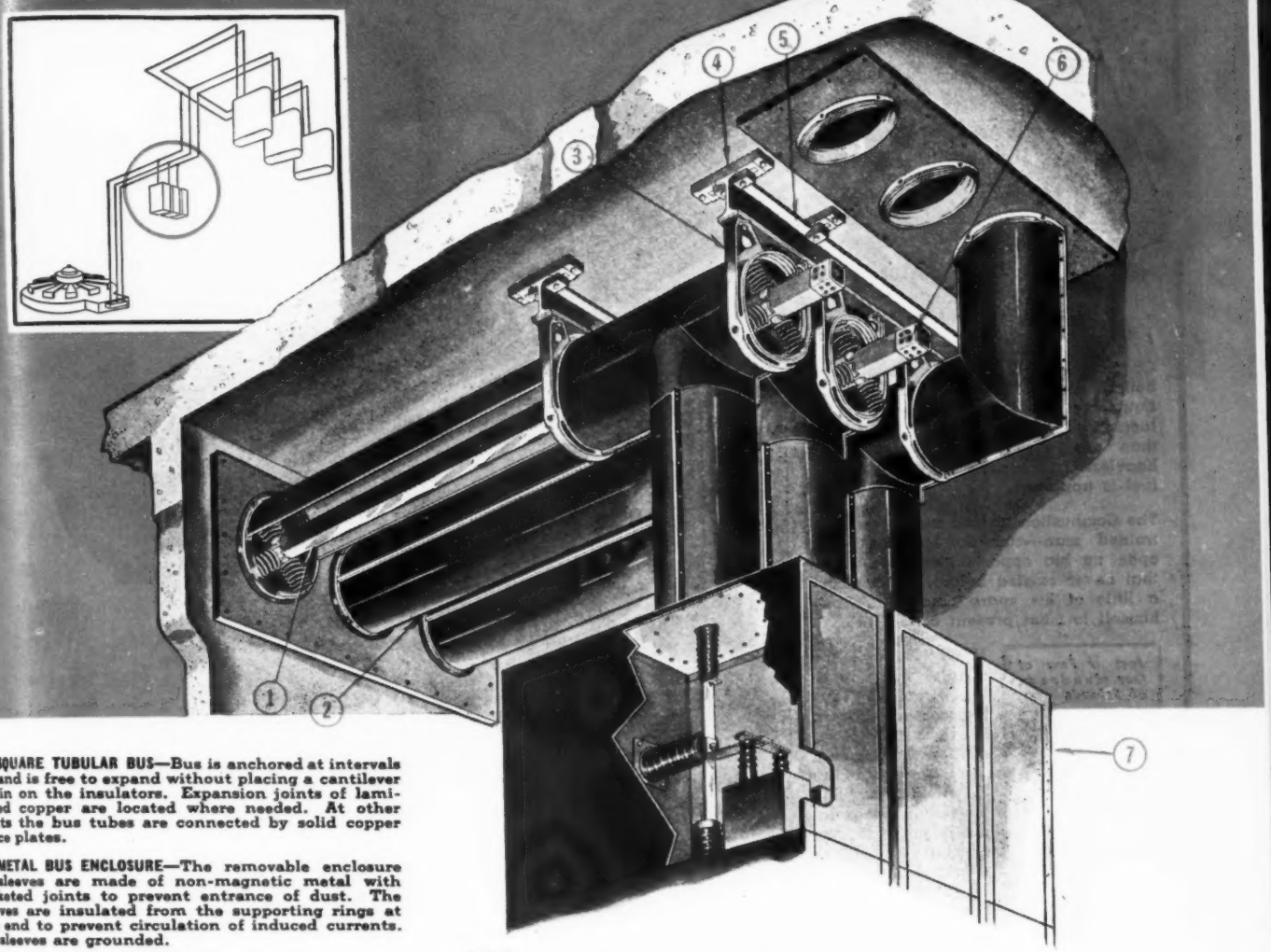
WITH I-T-E METAL-ENCLOSED BUS



1 SQUARE TUBULAR BUS—Bus is anchored at intervals and is free to expand without placing a cantilever strain on the insulators. Expansion joints of laminated copper are located where needed. At other joints the bus tubes are connected by solid copper splice plates.

2 METAL BUS ENCLOSURE—The removable enclosure sleeves are made of non-magnetic metal with gasketed joints to prevent entrance of dust. The sleeves are insulated from the supporting rings at one end to prevent circulation of induced currents. All sleeves are grounded.

3 SUPPORTING RING AND INSULATORS—The porcelain insulators are in compression and are free from cantilever strain because the bus can move longitudinally. Insulation is equal to that of connected apparatus. Each insulator is mounted in a ball and socket support to prevent any stresses except compression.

4 SUPPORTING BRACKET—These brackets have slotted bolt holes in serrated bearing pads to allow accurate alignment of the bus during erection. Mounting bolts are grouted in the masonry. Installation is easy because of the accessible design of the whole structure.

5 GROUND BUS—The ground bus is amply proportioned and bolted to the supporting brackets. The enclosing sleeves fit machined surfaces in the supporting rings when the sleeve clamping bolts are drawn up tight.

6 SILVER-SURFACED BUS JOINT—All bus joints are silver-surfaced to give low voltage drop and permanent freedom from overheating. At elbows like this the buses are joined with laminated copper expansion connectors.

7 POTENTIAL TRANSFORMER COMPARTMENT—The advantage of isolated-phase construction extends to these potential transformer compartments. Steel cells with dust-excluding gaskets give full protection. Short circuits cannot extend from phase to phase.

Whether conditions call for segregated-phase construction, as in the example illustrated, or a simple arrangement of conductors, electrical buses should be planned in the interest of life-long dependability and economy. With I-T-E such planning is an established business which starts with design and carries through complete assembly. I-T-E engineers have pioneered major improvements to provide structures that operate within specified temperature limits, are adequate electrically and mechanically and cause minimum voltage drop.

A detailed summary of the problems to be considered in planning is presented in a 24-page, illustrated booklet, "Electrical Buses and Bus Structures", written by William Deans, I-T-E Chief Engineer. It is Bulletin 4211, and a few copies are on hand.

A three-phase metal enclosed bus is shown because it is typical of thoroughly modern structures. The small diagram indicates position between generator and transformers.

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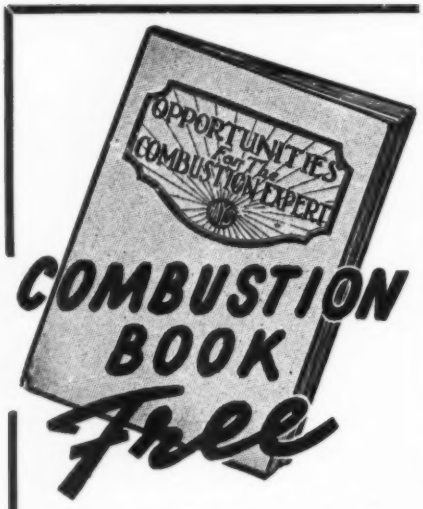

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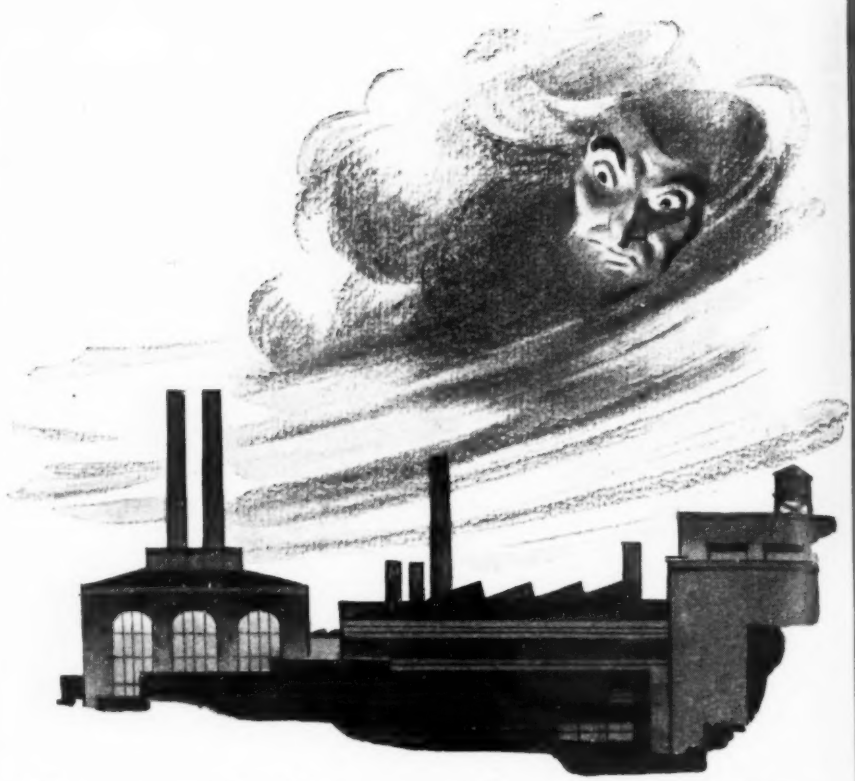

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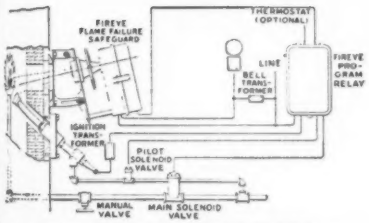

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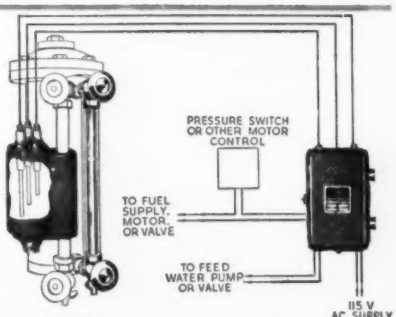
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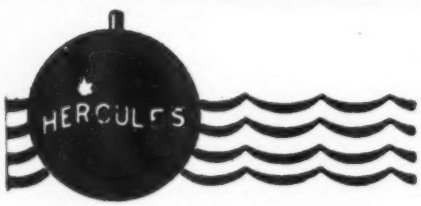

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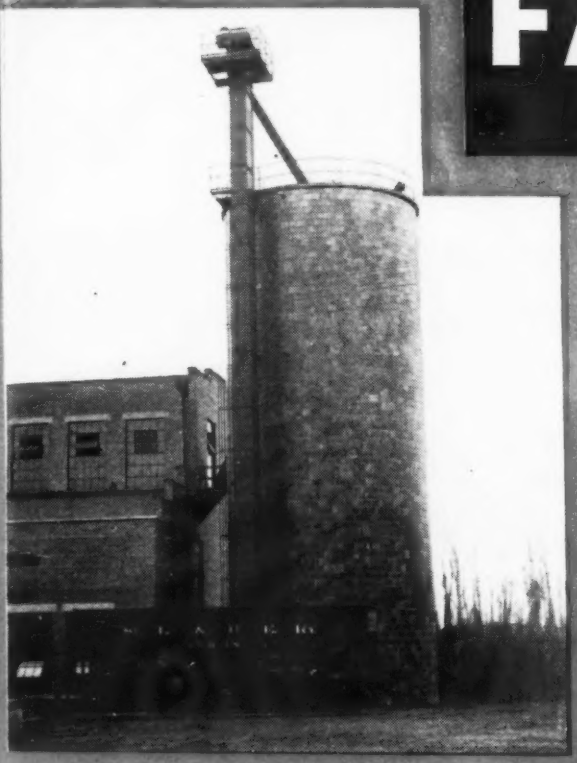

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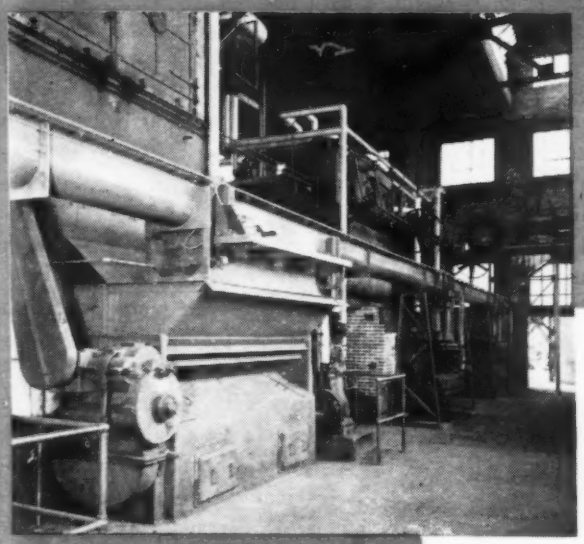

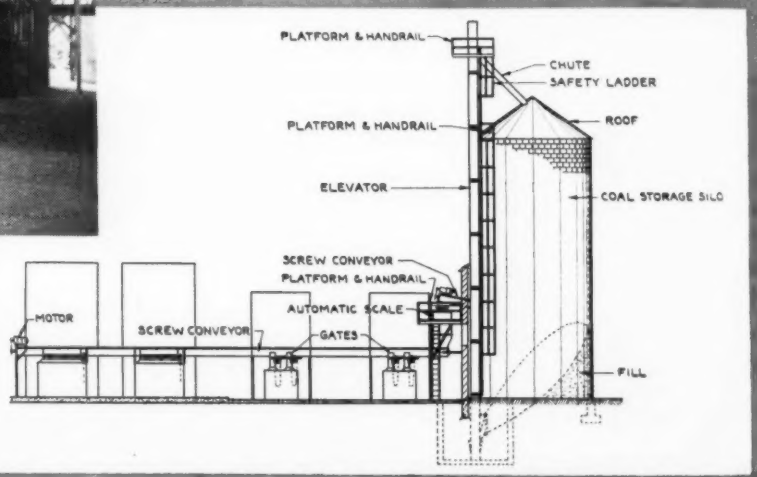

Our Engineers will be pleased to discuss the many advantages of the Fairfield Silo System as it pertains to your plant. Write for interview or ask for full descriptive bulletin showing numerous applications now in successful operation.

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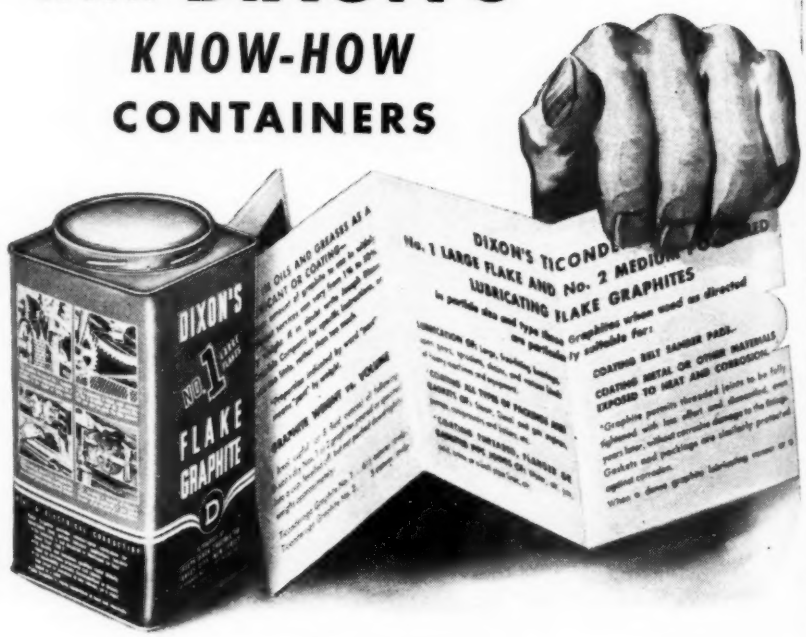

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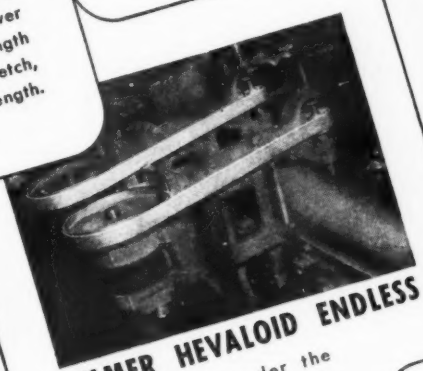

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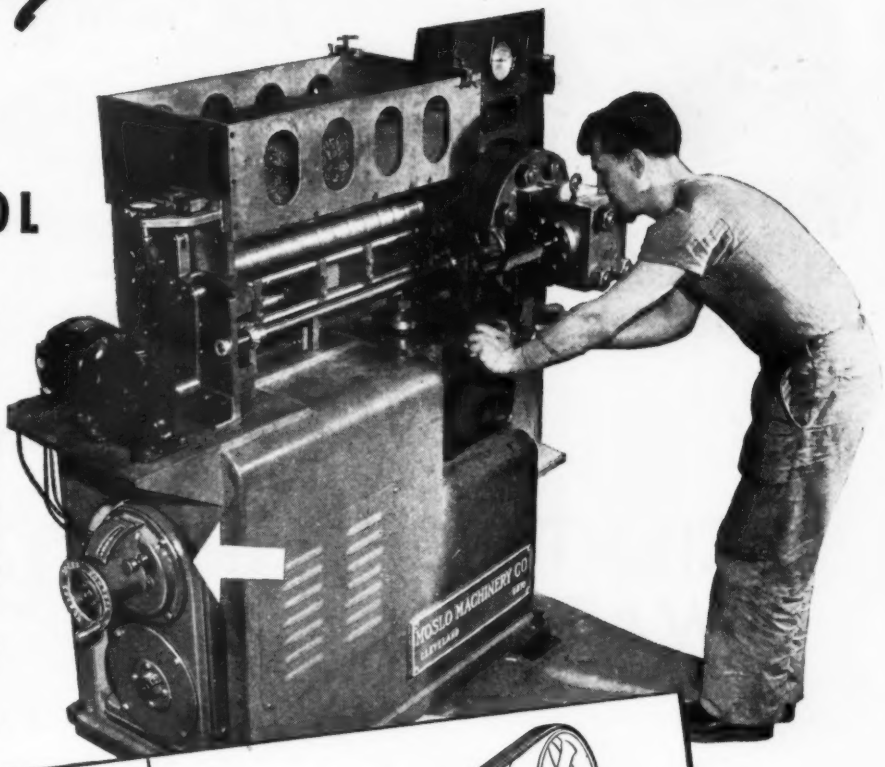

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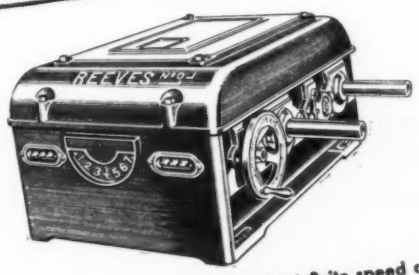

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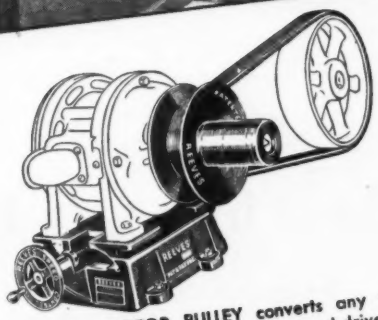

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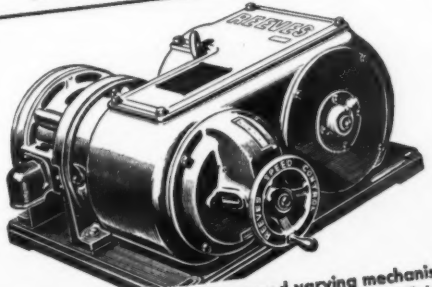

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This authoritative 128-page book on variable speed control describes the complete REEVES line of speed control equipment. Ask for Catalog-Manual P.

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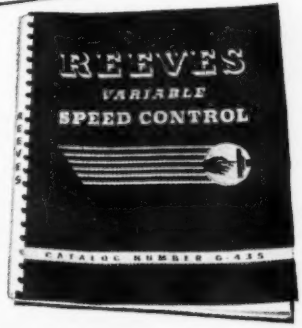
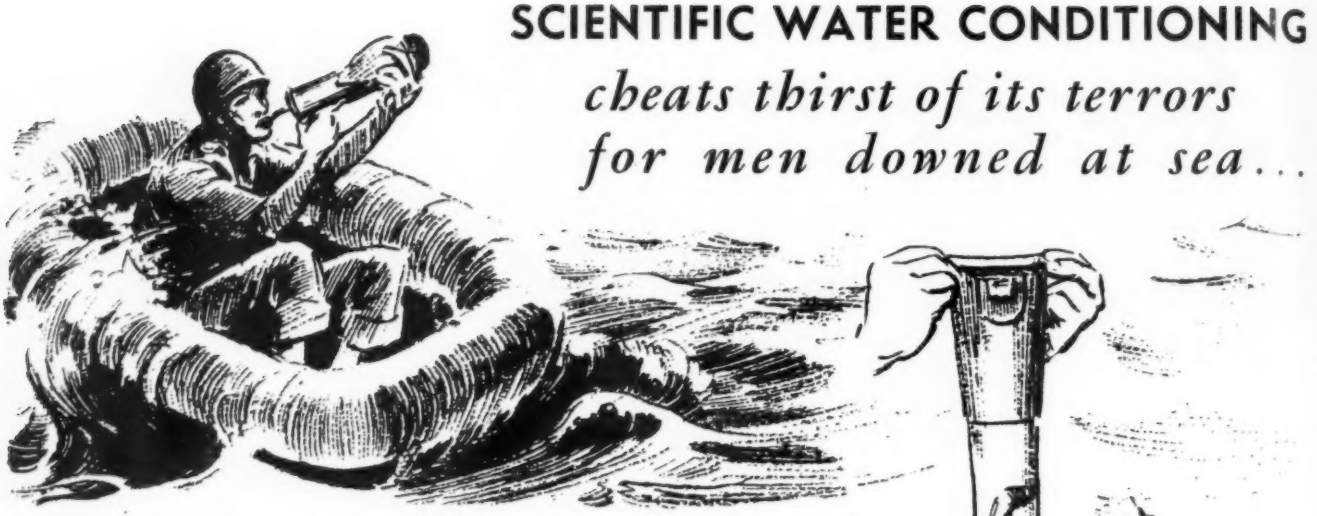


REEVES *Accurate Variable* Speed Control

SCIENTIFIC WATER CONDITIONING

cheats thirst of its terrors for men downed at sea...



Today the man forced down at sea simply drops a chemical "pill" into a plastic bag full of sea water. In 20 minutes he has a pint of clear water, from which the salt has been precipitated. Thirst is checked before it can start!

SCIENTIFIC WATER CONDITIONING

also checks trouble before it can start

in the modern industrial plant

WHEN the control of water conditioning in your plant is taken over by Bird-Archer it means far MORE than simply a routine analysis and a general recommendation. For you know that the generation of steam and its feed water problem is a many-sided affair with many different factors affecting it. Bird-Archer Service is truly a•*scientific* Service because it includes the correlated work of (1) CHEMISTS (for analysis and conditioning treatments) — (2) CHEMICAL ENGINEERS (for the study of related processing problems)—and (3) MECHANICAL ENGINEERS (for practical power plant operation). Thus, trouble is checked from *every* angle. And the correct answer, based upon a COMPLETE study of all related conditions in YOUR plant, is obtained. ***Please feel free to consult us for preliminary discussion, without obligation on your part.***

SURVEYS PLANT STUDIES CONSULTATIONS TREATMENTS
PLANT DESIGN SUPERVISORY SERVICE LABORATORY SERVICE

THE BIRD-ARCHER CO.

Scientific Water Conditioning

NEW YORK 17, N. Y. • CHICAGO 11, ILL. • PHILADELPHIA 40, PA. • MONTREAL, CAN.

TYPICAL DIESEL LUBRICATION PROBLEMS:

1. Port Clogging

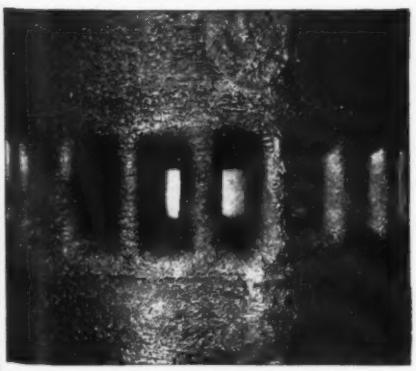
The plugging of intake and exhaust ports is frequently a factor in the operation of two-cycle Diesel engines.

Port clogging results from the combination of fuel soot with the residues of oxidized lubricating oil, which acts as a binder to plug the port openings. This clogging, of course, results in a sharp drop in efficiency.

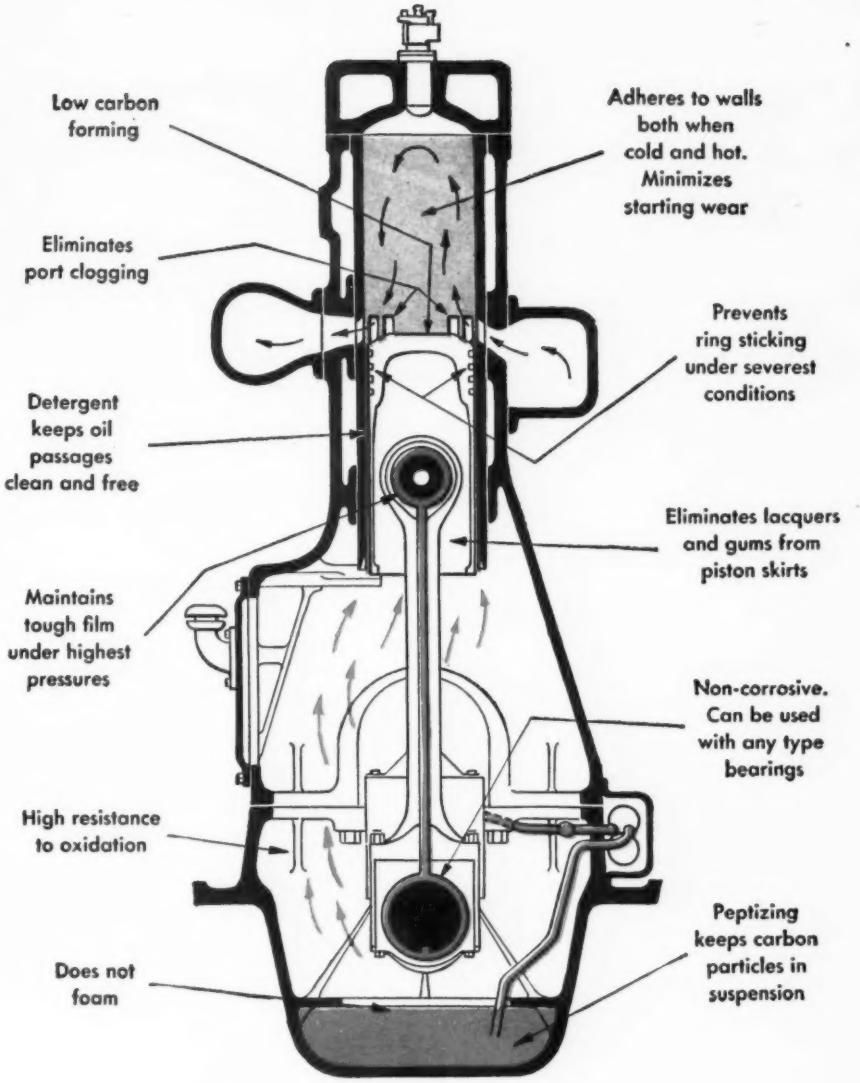
In simplified form, the deterioration of lubricating oil in an engine involves a combination of oxygen and oil at high temperatures. As the oil continues to absorb more and more oxygen, acids called "oxyacids" are produced. These oxyacids tend to polymerize or form very large, oil insoluble molecules. These form the binder for the deposits on intake and exhaust ports.

The problem, then, of eliminating these deposits may be solved by the use of a lubricating oil properly compounded to prevent it becoming a binder. RPM DELO accomplishes this in four separate ways.

1. RPM DELO is manufactured from a carefully selected base oil containing natural inhibitors highly resistant to oxygen. It contains no heavy residues which may be left behind to act as a binder for the fuel soot.



Unretouched photo shows air ports from 1000 h.p., 12-cyl., 2-cycle Diesel streamliner locomotive after being lubricated with RPM DELO for 127,590 miles. This is typical of absence of port clogging experienced when RPM DELO is used.


Low carbon forming
Adheres to walls both when cold and hot. Minimizes starting wear
Eliminates port clogging
Prevents ring sticking under severest conditions
Detergent keeps oil passages clean and free
Eliminates lacquers and gums from piston skirts
Maintains tough film under highest pressures
Non-corrosive. Can be used with any type bearings
High resistance to oxidation
Peptizing keeps carbon particles in suspension
Does not foam

Diagrammatic sketch of 2-cycle Diesel, showing the typical location of intake and exhaust ports and the advantages obtained from the use of RPM DELO.

2. RPM DELO contains a powerful oxidation inhibitor, which greatly reduces the rate at which the oil absorbs oxygen.

3. RPM DELO has chemical detergent properties. The compounding material reacts with the oxyacids to render them essentially inert so that they are no longer able to polymerize to form gums and lacquers.

4. RPM DELO has peptizing properties which enable it to maintain soot and oxidation products in suspension in minute particles. This prevents these materials from settling from the oil and forming engine deposits.

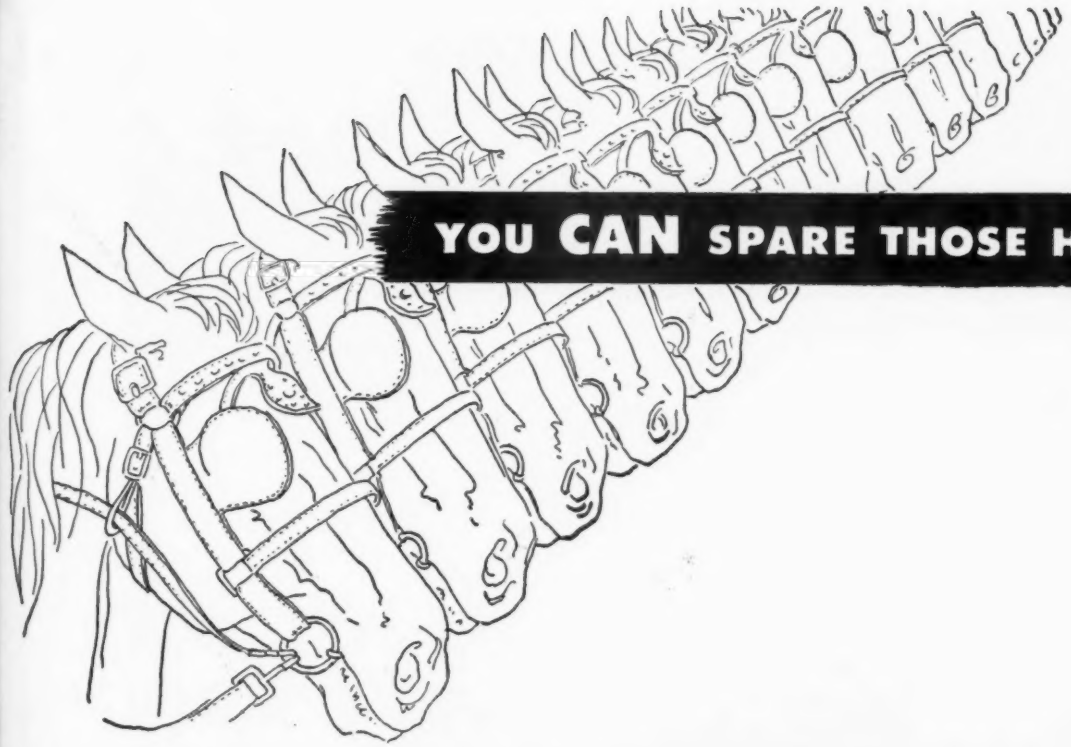
The elimination of port clogging, is, of course, only one of the valuable properties of RPM DELO. It also minimizes ring and cylinder wear, eliminates ring sticking, prevents excessive deposits on rings and will not corrode bearings.

RPM DELO has world-wide distribution and is marketed under the following names: RPM DELO, Caltex RPM DELO, Kyso RPM DELO, Signal RPM DELO, Sohio RPM DELO, and Imperial-RPM DELO (concentrate).

RPM DELO

STANDARD OF CALIFORNIA

A THREE-TIME CUSTOMER
2 UNITS—1939 ★ 2 UNITS—1940 ★ 3 UNITS—1941
User satisfaction is undeniably evident from the fact that the major utility that installed these two Byron Jackson Double Case Boiler Feed Pumps, has since placed two repeat orders, and now has in service five additional units for approximately the same duty. Name of this satisfied customer upon request.
★ Each of the pumps illustrated delivers 700,000 pounds per hour against a differential pressure of 1,600 pounds, at 330 degrees F. ★ Detailed Bulletin sent upon request—and Byron Jackson engineers are always available for consultation without charge or obligation.
BYRON JACKSON CO.



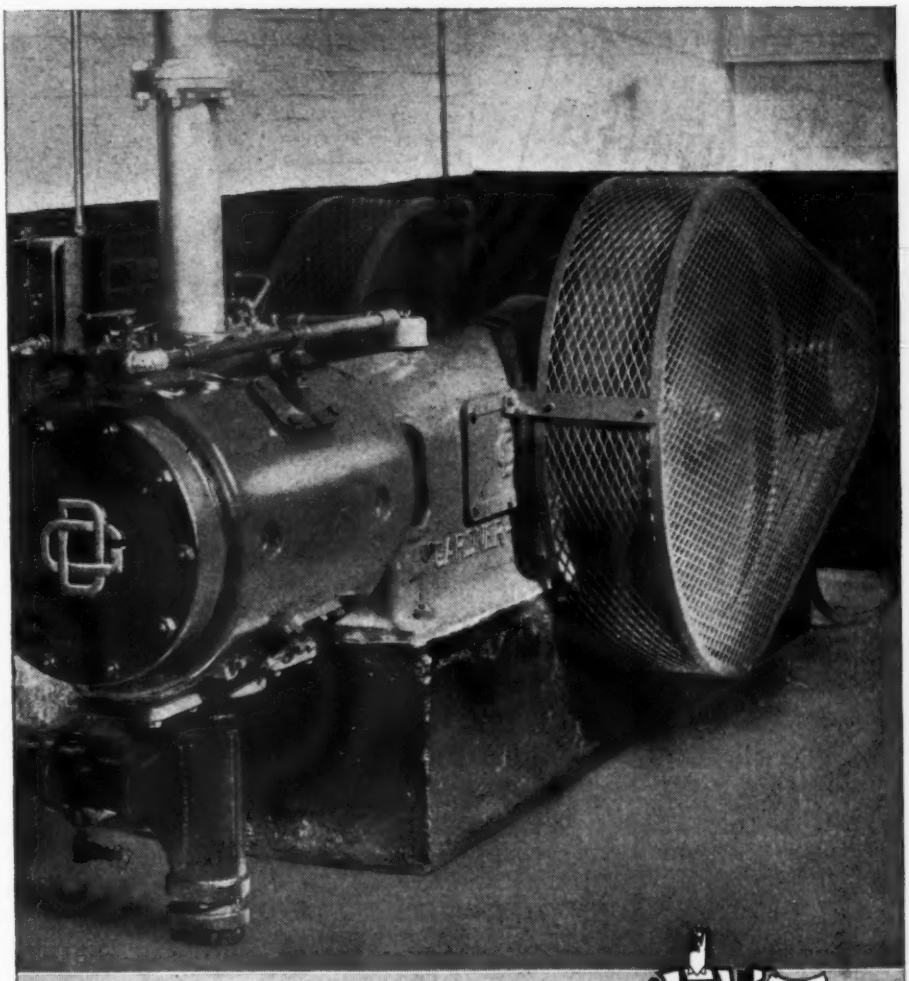
YOU CAN SPARE THOSE HORSES!

IT'S built especially to spare your horsepower—this Gardner-Denver "RX" Single-Stage Air Compressor. For here is a compressor that makes air do more work—yet uses remarkably little horsepower in the process.

"RX" performance is dependable—constantly—as is shown by user records from all over the country. Valve and port areas are large and unrestricted. Cylinder heads, valves and air passages are completely water-jacketed. No detail of design or construction has been slighted in making the "RX" Compressor a better compressor for the job—*your* job.

NOTE THESE ECONOMY-ASSURING FEATURES . . .

1. Air output is automatically regulated to fit air needs.
2. Maintenance costs are unusually low.
3. Rugged, dirt-free main frame.
4. Positive, flood-type lubrication system.

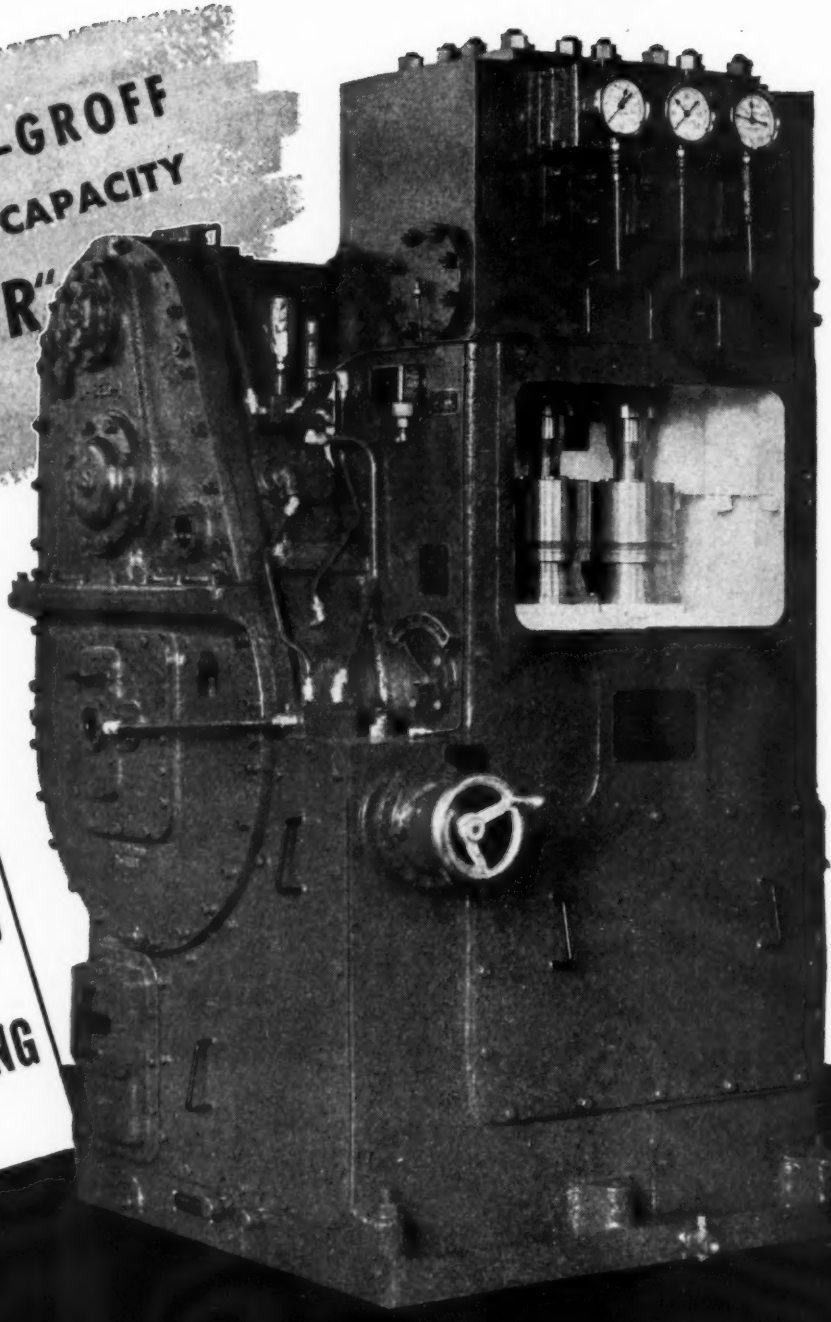


For complete information and specifications on Gardner-Denver "RX" Compressors, write Gardner-Denver Company, Quincy, Illinois.

Since 1859

GARDNER-DENVER

THE ALDRICH-GROFF CONTROLLABLE CAPACITY "POWR-SAVR" PUMP . . .



. . . for MAIN BOILER FEED and DESUPERHEATING SERVICE

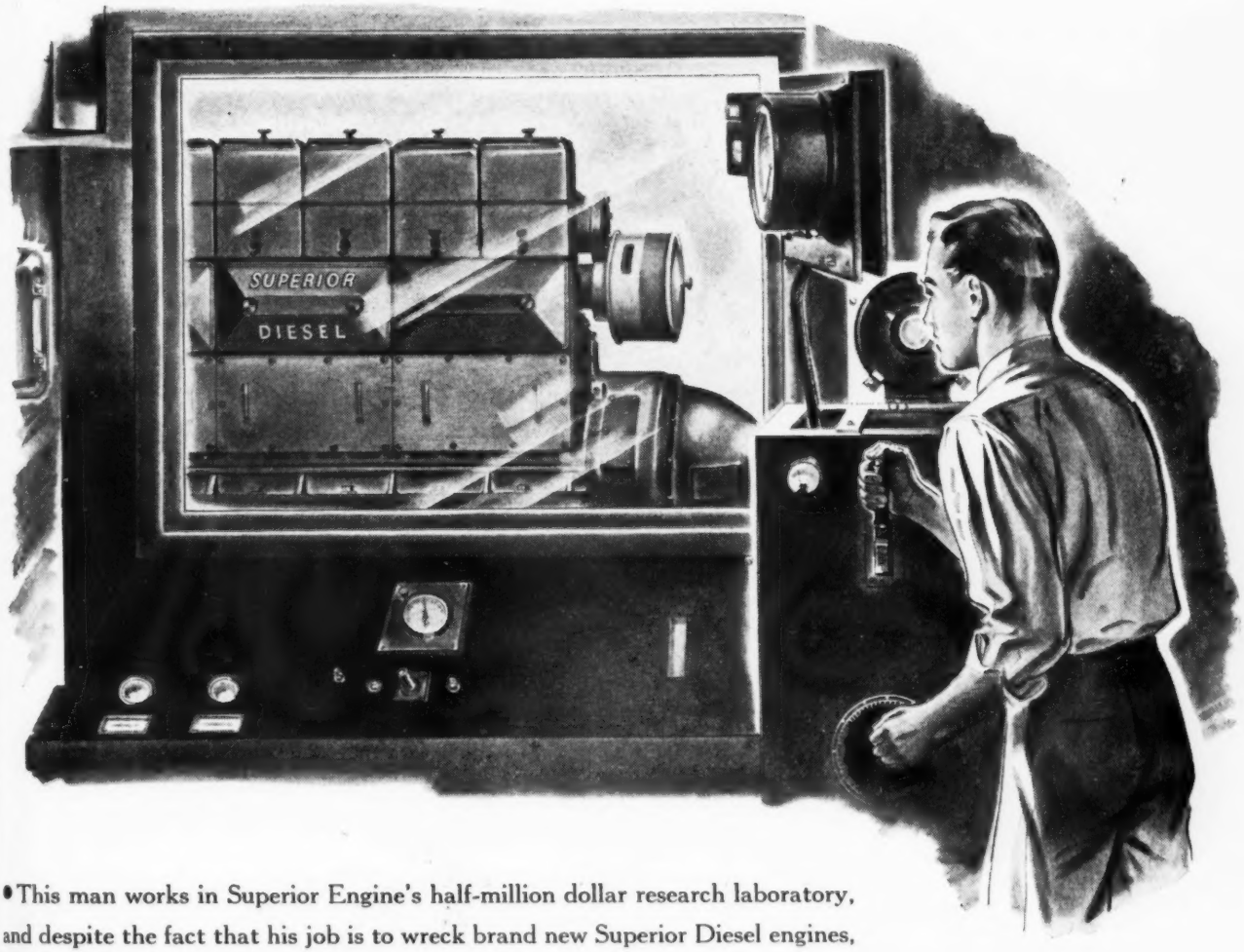
Aldrich-Groff Pumps provide for automatic or remote manual control of delivery, from zero to full capacity, at constant pump speed. Rate of delivery is controlled by varying the length of the plunger stroke, and power consumption is almost directly proportional to pump delivery. These pumps combine the positive displacement and high efficiency of the plunger type pump with the flexibility and smoothness of a centrifugal.

The use of these pumps with unit feed systems eliminates the pressure and power losses associated with throttling-type feed-regulating valves. They provide advantages of feed system simplicity, efficiency and mechanical reliability for the small and medium boiler plant using medium and high steam pressures, and for de-superheater feed service in even the largest power stations. Over 100 units in operation on land and sea with outstanding service records.

Write today for the Aldrich Bulletin 65. It gives full details, sizes and ratings of Aldrich-Groff "Powr-Savr" Pumps.

THE ALDRICH PUMP CO. ALLENTOWN, PENNA.

You'd fire this man if he worked for you...



This man works in Superior Engine's half-million dollar research laboratory, and despite the fact that his job is to wreck brand new Superior Diesel engines, he is one of our most valuable employees.

In specially built test cells containing dozens of scientific instruments and recording devices, he literally runs an engine to destruction under loads many times greater than that particular engine was built for. Under this terrific strain every reaction of the engine is recorded and careful study made of the findings. The results of years of such tests have improved the performance of Superior Diesels to a point where their economy and faithful performance is an accepted fact wherever there's a power job to be done.

SUPERIOR ENGINES

Division of The National Supply Co.

Executive Offices: Pittsburgh, Pa.

Sales Offices: Springfield, O.; Boston; New York; Philadelphia; Washington, D. C.; Jacksonville; Houston; Ft. Worth; Tulsa; Los Angeles; Chicago; Factory: Springfield, Ohio.

Superior **DIESELS** • STATIONARY, 31 to 1160 H. P.

MARINE, 28 to 1160 H. P. • GENERATOR SETS, 12½ to 770 kw.

For SAFETY'S sake . . . use CONDUIT

(Full Weight Rigid Steel)

WHEN steel conduit is available for general use again, you will want to rewire many of your wartime systems -- especially to replace substitute material in such critical places as these:

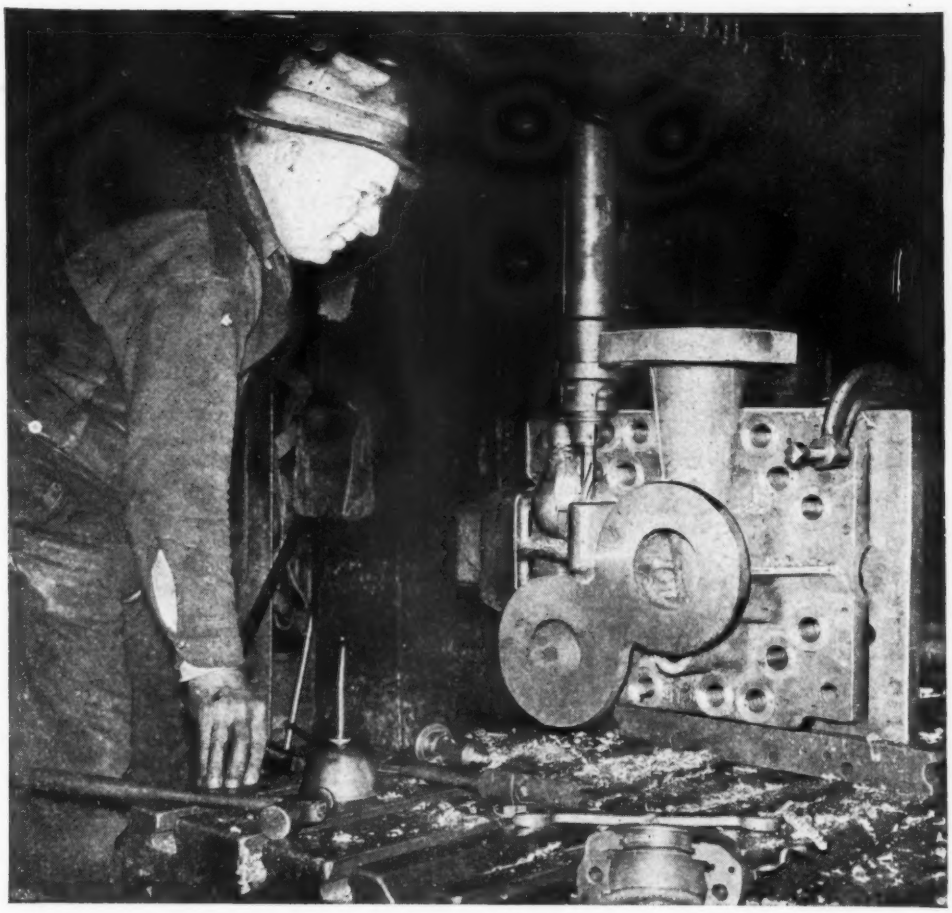
1. Where there is excessive vibration.
2. Where corrosion is a possibility.
3. Where there is moisture or vapor.
4. Where accumulating dust and dirt form a hazard.
5. Where there is danger of crushing or mechanical injury.

Standard-threaded full-weight rigid steel conduit affords the only sure protection against such hazards, because it has strength that endures. The most widely used rigid steel conduit, preferred by electrical contractors for its unvarying strength and durability, is YOUNGSTOWN BUCKEYE CONDUIT.

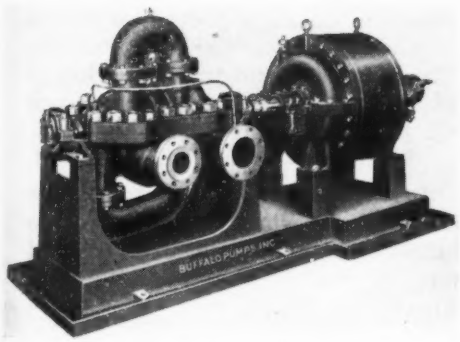
Above - This installation will last as long as the building itself stands, complete protection for complex wiring systems.

THE YOUNGSTOWN SHEET AND TUBE COMPANY
YOUNGSTOWN 1, OHIO
Manufacturers of
CARBON, ALLOY AND YOLOY STEELS

Ask your distributor for:
Youngstown Buckeye Conduit . . . Pipe and Tubular Products . . . Sheets . . . Plates . . . Tin Plate . . . Bars . . . Rods . . . Wire . . . Nails . . . Tie Plates and Spikes



Fussy? Sure, It's Part of His Job!



"Buffalo" Boiler Feed Pumps are rendering distinguished service in hundreds of power plants—pumps designed and built to render unfailing performance, even under the extreme demands for peak power delivery over extended periods. Bulletin 980-A brings you engineering data on the type and capacity of pump for your particular operations.

You might call this "Buffalo" craftsman fussy, watching with an eagle eye over the machining of a "Buffalo" Pump casting. Actually, he's just painstakingly practical—and that is part and parcel of the "Buffalo" tradition.

Careful manufacture, combined with intelligent design and thorough testing before shipment—these are the threefold advantages which assure you extra years of efficient operation every time you specify a "Buffalo".

Install a "Buffalo" Pump, and you invest wisely!

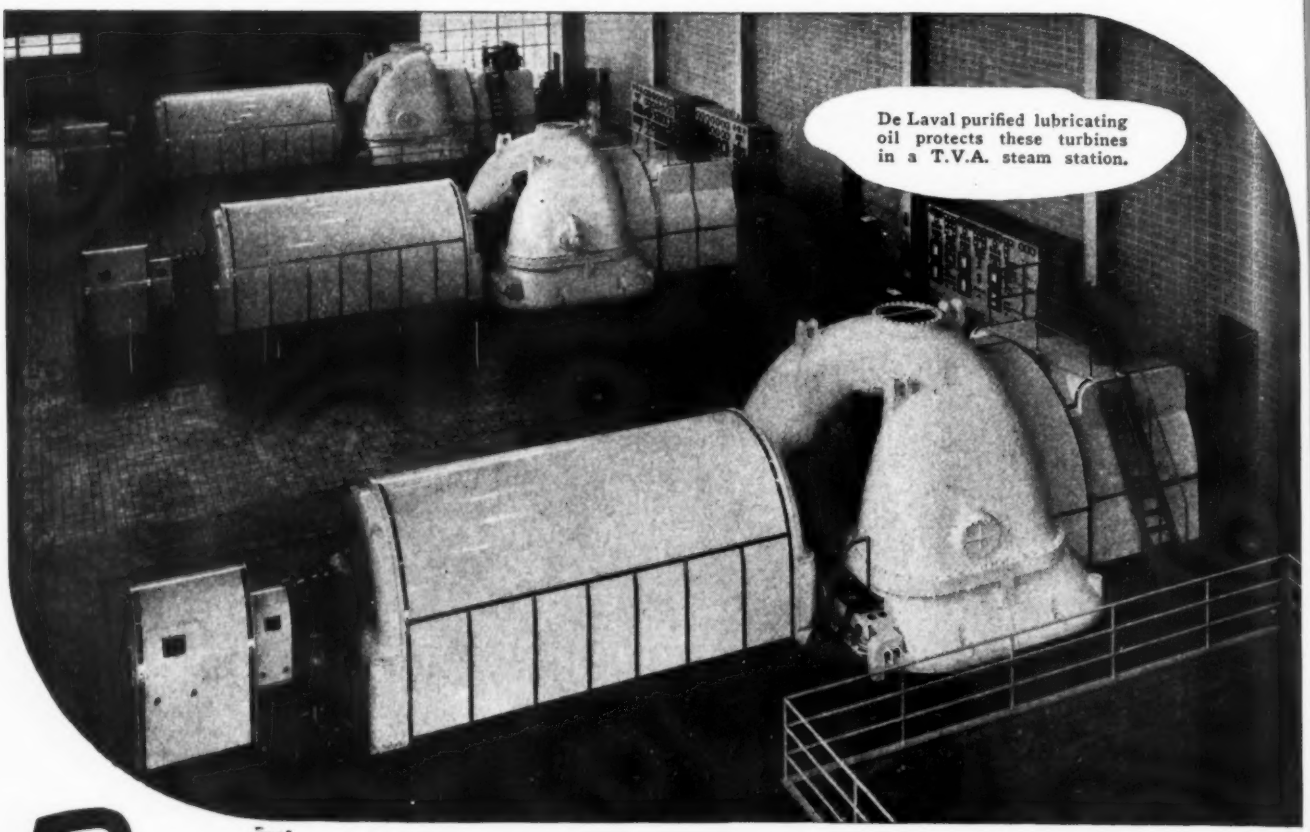
BUFFALO PUMPS, INC.

488 BROADWAY, BUFFALO, N. Y.

Canada Pumps, Ltd., Kitchener, Ont.

ARMY E NAVY

"Buffalo" BOILER FEED PUMPS



DE LAVAL PROTECTION
Helps Keep Turbines on the Line

TO the 96% of America's largest utilities that use De Laval Oil Purifiers may be added many government power projects. And whether the power plant is government-owned, a private plant or a central station, the protection afforded by De Laval Oil Purifiers against the troubles caused by dirty lubricating oil is a positive factor in making uninterrupted operation possible. Most of the larger turbines in the country already have De Laval protection—so do hundreds of smaller turbines and other prime movers.

By continuously by-passing a portion of the oil through a De Laval Centrifugal Oil Purifier, water and dirt are removed and the formation of sludge is retarded. Danger of bearing failure and of trouble with other lubricated parts is practically eliminated when the oil is thus purified.

Either by themselves or as part of the De Laval-Funk Process, these machines keep lubricating oil in a condition most nearly identical with that of new oil.

It will pay you to investigate.

★ ★ ★

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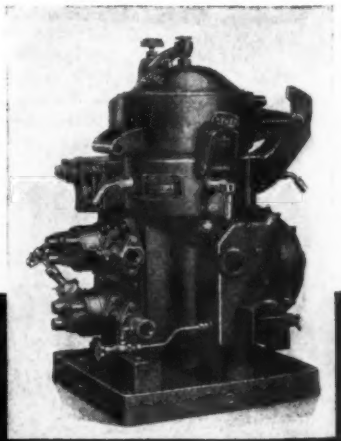
165 Broadway, New York, 6 — 427 Randolph St., Chicago, 6
DE LAVAL PACIFIC CO., 61 Beale St., San Fra cisco, 19
THE DE LAVAL COMPANY, Limited
MONTREAL PETERBOROUGH WINNIPEG VANCOUVER



DE LAVAL OIL PURIFIERS

YOU'VE GOT TO HAVE SPEED TO SINK SUBS...

BUY TO LAST
SAVE TO WIN

..and it takes a battery with plenty of zip to crank a Diesel engine

That's why Exide Batteries, specifically designed for this work, get Diesel cranking jobs in all parts of the world under all conditions.

Development and refinement improvements that have been made in high-speed Diesels have been matched, step-for-step, by Exide engineers. An Exide Battery that is recommended for a specific cranking job can be selected with the same assurance of satisfaction under all conditions as can the engine itself. Its complete dependability, long-life, and extreme ease of maintenance mean the saving of vital materials . . . and equally vital man hours.

Write for a FREE copy of the Exide catalogue on Heavy-Duty Batteries. It tells you what to order, how to order, and how to get the most from your Exide Heavy-Duty Batteries.

THE ELECTRIC STORAGE BATTERY COMPANY
Philadelphia 32
Exide Batteries of Canada, Limited, Toronto

ARMY E NAVY

Exide
BATTERIES
FOR CRANKING
DIESEL ENGINES

The AIR in Your Plant—DOES IT HELP OR HINDER?

Neither manpower nor machines can do a 100% production job, unless the air is clean, pure and correctly temperatured.

Are you letting production lag and costs mount because you haven't the necessary air handling and conditioning equipment?

Thousands of plants turn such problems over to Clarage. We have developed, through more than a quarter-century of experience, the proper equipment for any application.

And we have offices in key cities to give you expert, first-hand assistance. Write or 'phone us about your requirements.

COOLING, HEATING, HUMIDITY CONTROL

Floor type unit shown above; space-saving, suspended type at left.

NO INSTALLATION DELAYS— "Whole Works" in One Assembly

Step up your war production and insure lower post-war costs by maintaining the RIGHT atmospheric conditions. Clarage Multitherm (air conditioning) Units reduce this vital job to simplest form — low first cost; quickly installed without expensive building alterations; no ducts required.

Units are available for cooling only, heating only, or complete, year-round control of temperature and humidity. Sizes to meet every need.

✓ CUT YOUR COSTS

✓ SPEED PRODUCTION

✓ DECREASE ABSENTEEISM

FRESH AIR Ventilation for Large Areas

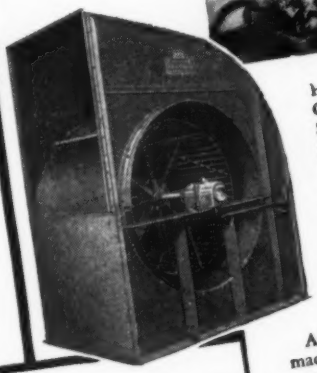


Photo above shows Clarage Ventilating System serving large industrial plant — fan at right; air washing and cleaning equipment at left.

Fans are built in 28 sizes; 500 to 100,000 c.f.m.—slow speed for belt drive; high speed for direct motor drive.

Air washers are "tailor-made" to meet individual service conditions.

READY UNITS for Small Space Ventilating

Here are ideal units for ventilating small factory or office areas — removing fumes and odors from laboratories, etc. The most complete line of small ventilating blowers on the market; 13 sizes with capacities 200 to 700 c.f.m. Most sizes can be operated from lighting circuit.

Built for long service without any attention except motor bearing lubrication.

Removing Dusts, Fumes, Smoke, Noxious Gases

—and for Pneumatic Conveying

Clarage Exhaust Fans are made to cover all kinds of exhaust and blow pipe needs — carrying away gritty, injurious dusts from emery and buffing wheels, fumes from chemical processes and paint spray operations — used wherever an industrial plant must be rid of atmospheric pollution.

As in all other Clarage Fans, wheels are both statically and dynamically balanced. Dust-proof, oil-tight bearings standard equipment. Large range of sizes.

How to Buy CLARAGE EQUIPMENT in War-Time

We are able to furnish any industrial plant with practically any type of Clarage product, providing the order carries a priority rating of AA-5 or better. ***Deliveries on most Clarage equipment can be made promptly.***

COMPLETE AIR CONDITIONING

COOLING

VENTILATION

FACTORY HEATING

MECHANICAL DRAFT

FANS and BLOWERS for INDUSTRIAL NEEDS

Clarage Fan Company Kalamazoo, Mich.

APPLICATION ENGINEERING OFFICES IN ALL PRINCIPAL CITIES

GARLOCK 234 gives long, dependable service on rotary or centrifugal pumps handling hot water, cold water, caustic solutions or weak acids. All sizes from ⅛" to 1¼".

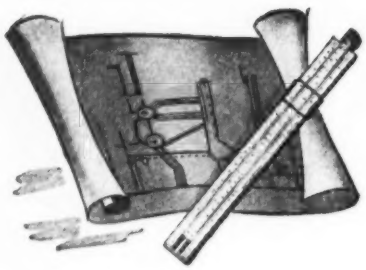
Garlock Products Help Keep Things Moving!

GARLOCK packings, gaskets and KLOZURE oil seals play a vital role in war plants throughout America . . . and in U. S. warships, planes and tanks throughout the world. Our Armed Forces as well as our industries *rely* on the *dependable performance* of GARLOCK products to keep things moving *fast*—for Victory.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada:
The Garlock Packing Company of Canada Ltd.,
Montreal, Que.

GARLOCK



Case #451—The Future of This Manufacturer Was Put in Our Hands

. . . And Bigelow-Liptak engineers designed furnace enclosures that are today making possible increased production with greater efficiency.

LARGE ORDERS of castings were waiting to be filled by an Ohio malleable and steel casting company. Furnaces were outmoded and inefficient. Large, cumbersome double doors swung out to take up the only otherwise vacant plant space that could be used for constructing a much needed additional annealing furnace. When these doors were closed a center gap approximately a foot wide had to be laboriously bricked up and then torn away before and after each cycle of operation. This procedure was not only troublesome and costly but slowed down production. Built-up arches were cutting down efficiency and placing damaging thrusts on side walls.

Improved enclosure designs and doors would be necessary if this malleable company was to increase its capacity and keep pace with its multiplying war orders.

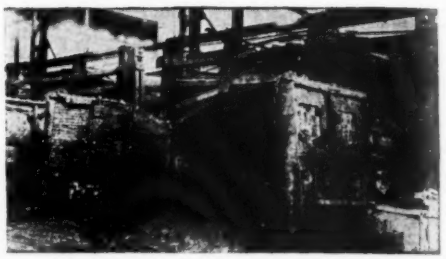
The Solution

Hundreds and hundreds of furnace enclosure problems had been successfully solved by the application of Bigelow-Liptak engineering principles and skill, but this one, like every other one, was different. It presented its own peculiar characteristics and individual problems. There could be no "stock" recommendations that would adequately solve the door and enclosure problem and bring about more efficient and increased production of castings.

As is always the case with Bigelow-Liptak, a complete analysis of the furnace encasement problem was made by its engineering staff. Based on resulting conclusions, a design was worked out. A unit-suspended arch was designed that would provide more uniform distribution of heat and eliminate thrusts on side walls. Design would utilize old construction as far as possible to keep costs at a minimum. Old solid masonry side walls were retained but the use of Bigelow-Liptak unit-suspended arches would permit easy installation of unit-suspended side walls later for increased efficiency and economy. In order to save plant floor space and make possible the construction of a needed additional furnace, doors were designed that could be raised and lowered to take the place of the heavy, inefficient and cumbersome swinging type shown in the photograph at the right. To accomplish this the doors would have to be of minimum weight, so Bigelow-Liptak 4½" Budget Walls were utilized. Conduction losses and weight would be reduced by the use of light weight refractories. A special Bigelow-Liptak sealing arrangement was provided for the top and bottom of the door. By redesigning the doors, Bigelow-Liptak engineers were able to add 30' to the length of the furnaces, thereby increasing the annealing capacity of each by 20%.

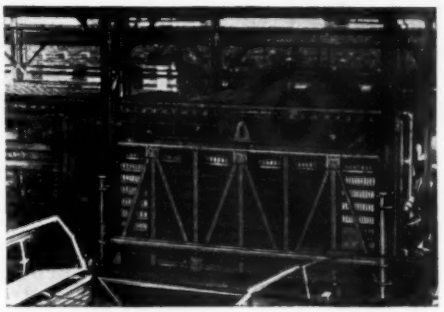
As a result of this Bigelow-Liptak analysis, enclosures and doors — photograph at the right — were worked out that not only made it possible for this malleable and steel casting company to secure room for an additional furnace but increased the production and efficiency of all of the old furnaces.

THIS WAS THE PROBLEM



This photograph shows part of the row of malleable furnaces before they were redesigned by Bigelow-Liptak engineers. Heavy, cumbersome double doors did not meet when closed, thus requiring the costly and inefficient job of bricking up space before and after each heating cycle. Built-up roof arches were inefficient and placed thrusts on sidewalls. Due to the large span (approximately 22'), the sprung arch front wall, directly above the arched doors, required constant maintenance.

HERE IS WHAT B-L ACCOMPLISHED



Two of the malleable furnaces after being redesigned by Bigelow-Liptak engineers. Unit-suspended arches eliminate thrusts on side walls and provide more uniform heat distribution to work. The Bigelow-Liptak door is a simple cross-braced fabricated steel framework to which the supporting castings and refractories are attached. A suspended drop curtain wall adjacent to the tops of the doors has eliminated maintenance at this previously vulnerable location. An existing crane is used for lifting the door and a safety device is provided at each side to lock it in the raised position. These vertical lift doors of Bigelow-Liptak unit-suspended wall construction provide more working space, tighter furnace closure, less wear and tear and generally improved operation.

What This Means To You

The significance of this problem and its complete solution by Bigelow-Liptak is much greater than any resemblance it may have to any of your problems. It serves to demonstrate the value you may receive by taking your problems to Bigelow-Liptak regardless of their type or size. Bigelow-Liptak's wide experience in designing enclosures includes every type of problem having to do with thermo-dynamics, ceramics and mechanics of materials. With Bigelow-Liptak there is no standard or set solution for every case. Individualized engineering, based on years of experience and sound engineering principles, is applied towards giving the customer the best and most economical solution to his particular needs. Our policy is to give first and foremost consideration to the needs of the user.

Free Catalogs

Our engineering staff will be glad to send you interesting catalogs or tell you how you could secure increased service and economy by the use of Bigelow-Liptak Unit-Suspended walls and arches in your plant. Write today.

BIGELOW LIPTAK Corporation

Unit-Suspended Walls + Arches

The Key to Operating Economy

BIGELOW-LIPTAK CORPORATION

DIVISION A. P. GREEN FIRE BRICK CO.

330 Curtis Building

DETROIT

NO...IT'S REALLY pH THAT DOES THE CLEANING!

THE "CURE-ALL" is a great idea—but it won't work. Today, in your business and in ours, we know that it takes a "specific" to make a cure or get a job done right.

One Does The Work Best

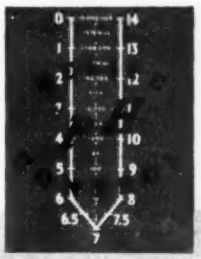
In every processing and cleaning operation there is one specific chemical combination which precisely fills the requirements of a particular situation and will do the job best. The difference between this correct material and anything else — even the closest approximation—is extreme. Kelite sees it every day in reports from Service Engineers in the field. You can see it in the unequalled speed, certainty and economy which the correct material makes possible.

pH Simplifies The Job

This matter of the right material for the job is so important that Kelite has gone to great lengths to attain it. Formerly, standardized test tubes of correct solutions were made up in the laboratory and used as models on the job. All this work was worth while, but it was slow... until we learned how to make use of pH. Now it's simple!

No Special Skill Needed

An operator does not have to be skilled to use Kelite pH Control. The pH values are lined up and compared in an easily-understandable form on the Kelite pH Chart. It's as easy to use as a yardstick! Your inquiry is invited.



Copyright 1944
Kelite Products, Inc.
909 East 60th Street
Los Angeles 1, Calif.

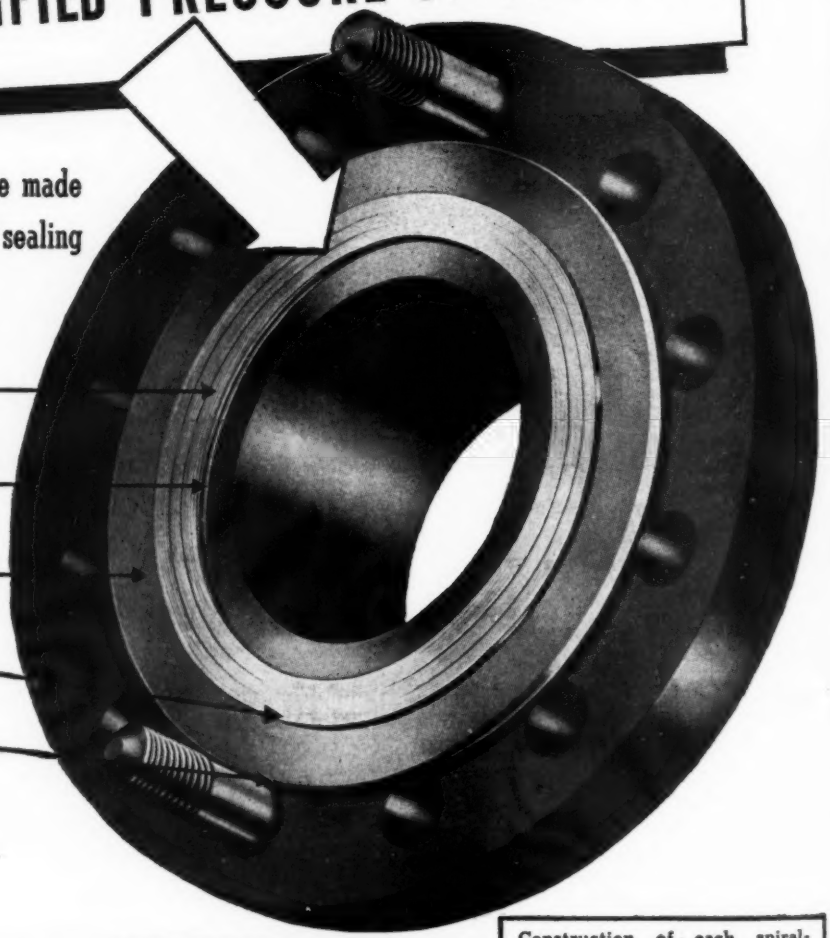
Manufacturing Plants in **LOS ANGELES, CHICAGO, PERTH AMBOY, HOUSTON**
Branches in Principal Cities.

KELITE
INDUSTRIAL CHEMICAL PROCESSES AND MATERIALS

FLEXITALLIC C-G GASKETS
ARE MADE *for* THE WORKING PRESSURE

DENSITY OF SEALING MEMBER IS CONTROLLED SO AS TO BE CORRECT FOR THE SPECIFIED PRESSURE OF THE LINE

Know how these pipe-flange gaskets are made and how they work. They'll do a great sealing job for you—as they now do in war



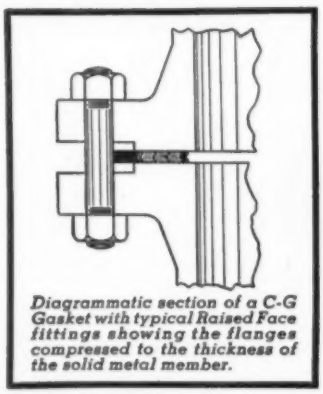
Seal is made and kept by spiral-wound, stainless-steel gasket which automatically expands and contracts with variations in temperature and pressure.

I.D. of gasket is clear of orifice at all points, offering no impediment in line.

Correct bonding load assured by surrounding solid-metal ring which serves as a thickness gauge for gasket when joint is made up.

Fit of surrounding ring, allows inner member to expand under compression.

Correct position assured by O.D. of gauge-ring which fits inside of bolts.



Diagrammatic section of a C-G Gasket with typical Raised Face fittings showing the flanges compressed to the thickness of the solid metal member.

Construction of each spiral-wound member is governed by design of fittings and by the required bonding load for working pressure and temperature.

Gauge-ring saves installation time. Gasket is correctly installed when flanges are brought down to the ring in making up joint.

"Flexitallic" Reg. U.S. Pat. Office

Representatives in Principal Cities

FLEXITALLIC GASKET CO., 8th and Bailey Streets, Camden, N. J.

Originators of Spiral Wound Construction

PACKAGES OF POWER

FOOTE BROS. ACTUATORS DO THE HEAVY MECHANICAL JOBS

Bros. Actuators are
on the Lockheed
ning P-38

As airplanes have increased in complexity, the job of the pilot has become more and more difficult. To free him of some of the heavy mechanical jobs, actuators have been developed which are, in effect, packages of power that perform many such jobs as opening and closing ventilators, operating wing flaps, retracting under-carriages and setting stabilizers.

These actuators are compact motor-driven units requiring gears of extreme precision. Their proved practicability on airplanes now flying points the way to greater use on planes now on drafting boards.

Because of the vast technical experience and manufacturing "know hows" acquired in producing high precision gears, gear units and actuators for the aircraft industry, Foote Bros. has developed new manufacturing methods that point the way to better "power transmission through better gears" for peacetime industry.

FOOTE BROS. GEAR AND MACHINE CORPORATION
5225 South Western Boulevard • Chicago 9, Illinois

Foote Bros. Actuators are used on the Lockheed Constellation C-69

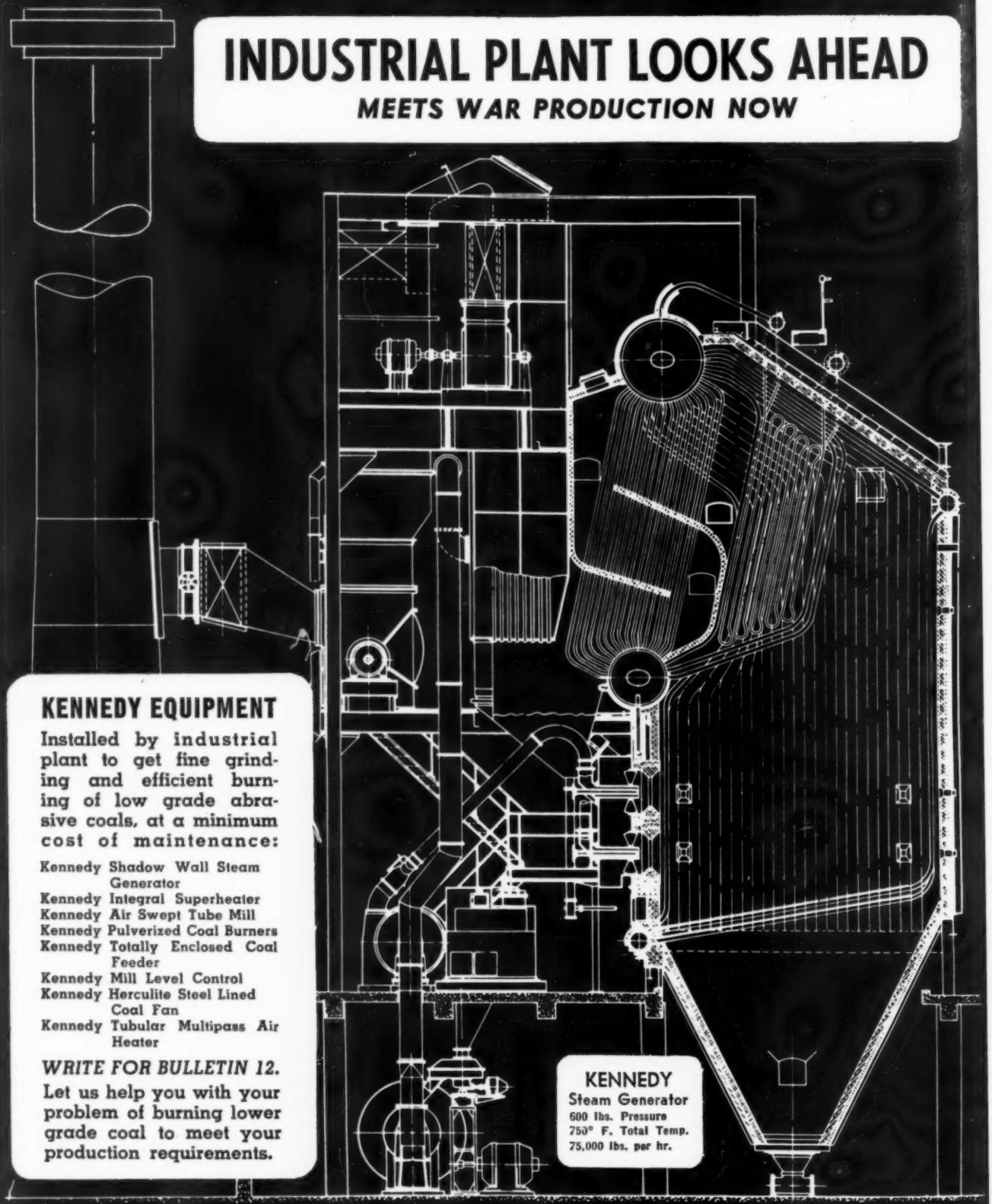
Foote Bros. Actuators are used on the Lockheed 349

FOOTE BROS.

Better Power Transmission Through Better Gears

INDUSTRIAL PLANT LOOKS AHEAD

MEETS WAR PRODUCTION NOW



KENNEDY EQUIPMENT

Installed by industrial plant to get fine grinding and efficient burning of low grade abrasive coals, at a minimum cost of maintenance:

Kennedy Shadow Wall Steam Generator
Kennedy Integral Superheater
Kennedy Air Swept Tube Mill
Kennedy Pulverized Coal Burners
Kennedy Totally Enclosed Coal Feeder
Kennedy Mill Level Control
Kennedy Herculite Steel Lined Coal Fan
Kennedy Tubular Multipass Air Heater

WRITE FOR BULLETIN 12.

Let us help you with your problem of burning lower grade coal to meet your production requirements.

Kennedy Products

ARMY E NAVY

Kennedy-Van Saun

MANUFACTURING AND ENGINEERING CORPORATION

2 PARK AVE., NEW YORK 16, N. Y.

FACTORIES:—DANVILLE, PA., CANADA, ENGLAND, AUSTRALIA

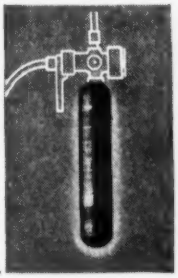
BAILING OUT FROM 8 MILES UP

—WHAT IT TAKES TO MAKE A RECORD PARACHUTE JUMP FROM 40,200 FEET ALTITUDE

Now that planes get up to 30,000 and 40,000 feet, airmen face the possibility of having to jump from altitudes as high as 8 miles up. Reaching the ground safely from the stratosphere presents many special problems —one of the most important is breathing.

To ascertain the effect of extreme altitude on the body, and to test emergency bail-out equipment, an officer of the U. S. Army Air Forces' Aero Medical Laboratories at Wright Field, recently made the highest parachute jump ever performed in America —40,200 feet from a Boeing Flying Fortress. The descent took 23 min. 51 sec. "I found out just exactly what I wanted," he said. "Now, we can say to the men, 'Okay, if you do have to get out, you can do it.'"

When flying in the "thin" air of high altitudes, aviators must be equipped with oxygen masks. Oxygen cylinders aboard the plane provide the source of supply, but if it becomes necessary to "bail out," the flyer must carry his oxygen with him.



The officer carried this reserve supply of oxygen in two metal bottles or bail-out cylinders, under high pressure, each good for about 20 minutes' supply. They are zippered into the thigh pockets in the outer flying suit. One bottle is connected by tube to an oral-nasal mask; the other is fed into a tube only, to be put into the mouth if the mask should fail to function, or the oxygen in the mask bottle should be exhausted. Before jumping, or in the event the plane oxygen supply is disrupted, the aviator turns a valve on the bail-out cylinder and breathes from this reserve supply of oxygen.

Metal oxygen bottles or bail-out cylinders are manufactured from Globe Seamless Steel Tubing. These cylinders are subjected to exacting metallurgical and ballistic tests. Globe ability to produce steel tubes of exacting characteristics is helping to make equipment of vital importance to our armed forces of the air.

This is what the well-dressed U. S. Army flier wears when he decides to bail out from 40,200 feet. Before climbing to this extreme altitude in a Boeing Flying Fortress, the test jumper wore regulation underclothes, trousers and blouse; an outer suit of gabardine and under it processed "chicken feather" suit for extra warmth; helmet and goggles, two pairs of gloves — one of silk, next to the hands — and another of leather.

★ STAINLESS TUBES
★ BOILER TUBES
★ GLOBEIRON TUBING
★ GLOWELD TUBES

GLOBE TUBES

★ CONDENSER AND HEAT EXCHANGER TUBES
★ MECHANICAL TUBING

5009

GLOBE STEEL TUBES CO., *Milwaukee 4, Wis., U. S. A.*

A Challenge to the Future ... in Motor Design

Copperspun ROTOR

Here is the new Fairbanks-Morse general purpose, continuous duty motor—designed for the future—available now! Never have more stamina, versatility and protection been built into a motor housing!

BUY WAR BONDS

NOTE THESE FEATURES

- **It is a 40°C. motor.**
- **It is a protected motor.**
- **It has an optional conduit box assembly.**
- **It has cross-flow ventilation.**
- **It has ball bearings—sealed in cartridge type closures.**
- **It has exclusive Fairbanks-Morse *COPPERSPUN ROTOR.***

Write Fairbanks, Morse & Co., Fairbanks-Morse Building, Chicago 5, Illinois.

FAIRBANKS-MORSE

DIESEL ENGINES
PUMPS
MOTORS
GENERATORS
WATER SYSTEMS
SCALES
STOKERS
FARM EQUIPMENT
RAILROAD EQUIPMENT

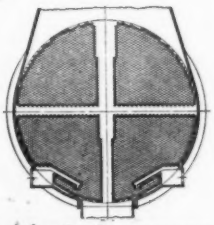
Motors

28 Years of C. H. Wheeler DUAL BANK CONDENSERS

KEEP PACE WITH IMPROVEMENTS IN TURBINE DESIGN

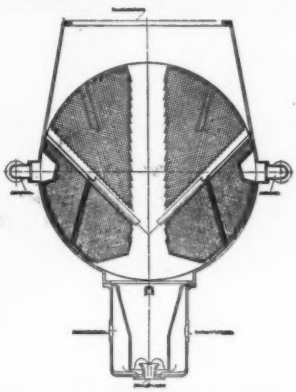
As the Steam Turbine was developed for higher vacuum, C. H. Wheeler Condensers kept apace of the same trend.

1916 **THE FIRST C. H. WHEELER CONDENSER** with which the steam ejector type air pumps were used is shown by this actual installation tube sheet.



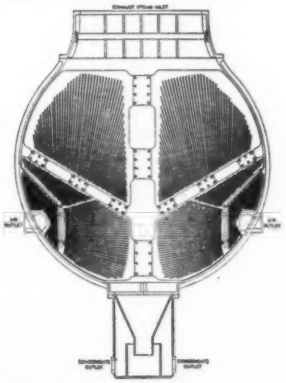
Result: Condensate temperatures within 5° of temperatures corresponding to vacuum.

1923 **IMPROVEMENT:** Wider steam lane and hotter condensate—shown in literature published at that time.



Result: This produced condensate temperature corresponding to temperature of vacuum and the oxygen content was less than 0.03 cc per litre.

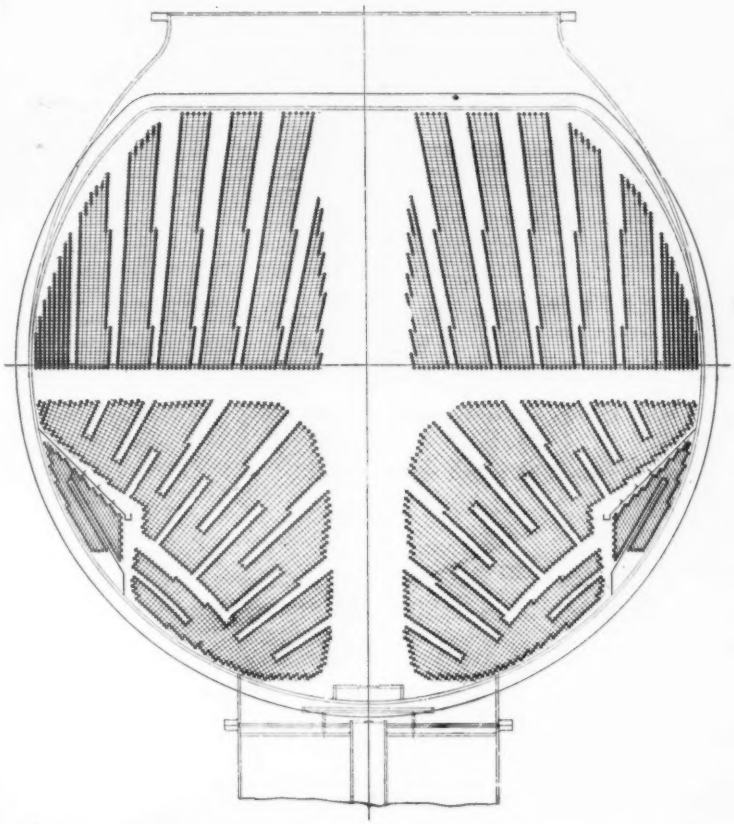
1929 **FURTHER IMPROVEMENT:** More open area for entering steam—illustrated in literature published at that time.



Result: Less pressure drop.

1944

NOW—Additional steam lanes give deeper penetration for the entering steam!

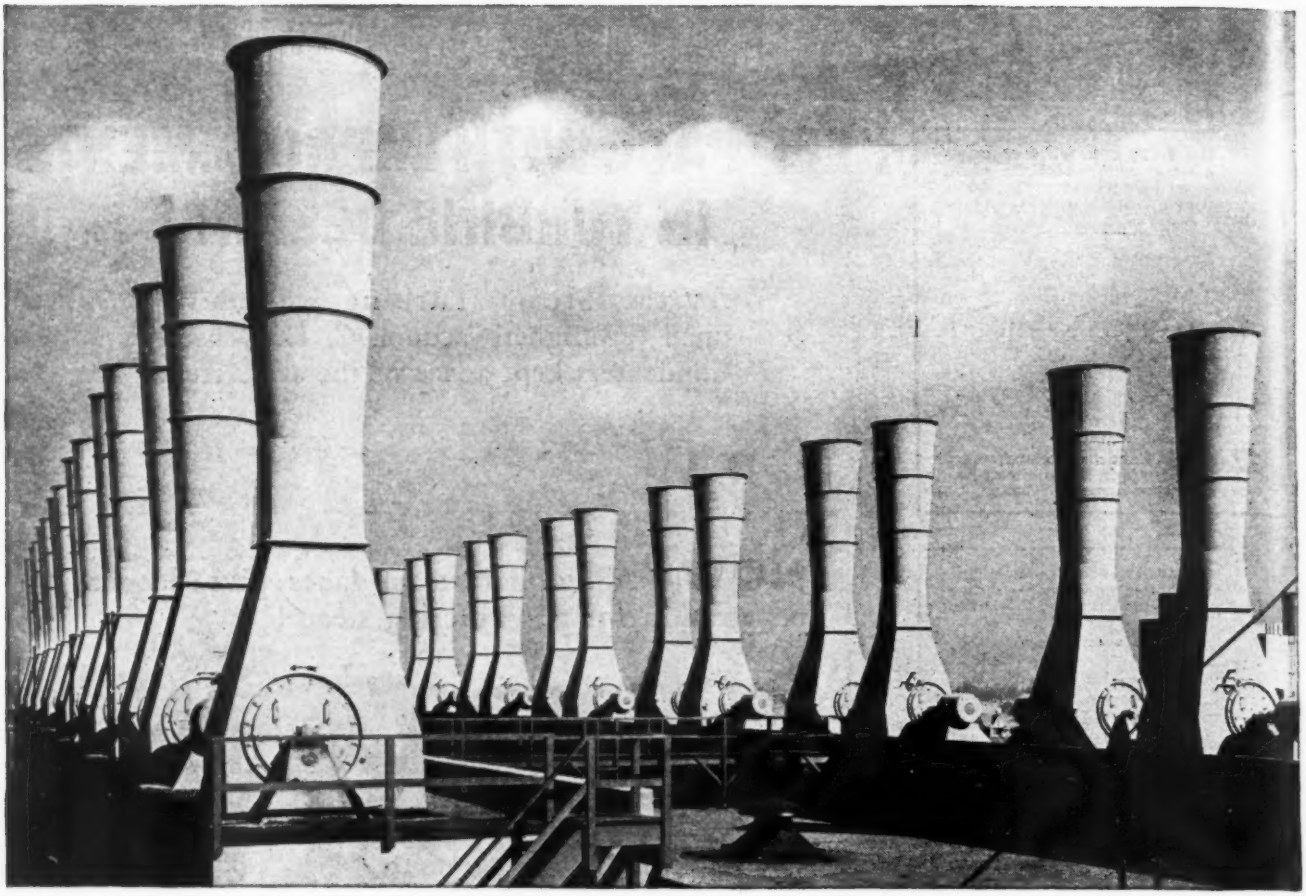


It is evident from the illustrations that the C. H. Wheeler Manufacturing Company has pioneered the development of this highly efficient Dual Bank Condenser.

PRODUCTS: Surface Condensers • Steam Jet Ejectors • Cooling Towers • Deck Machinery

C. H. WHEELER MANUFACTURING CO.

19th ST. *and* LEHIGH AVE., PHILADELPHIA, PA. *of Philadelphia*



THERMIX FAN-STACKS LINED UP FOR WAR!

These Thermix Fan-Stacks are evacuating approximately 2,000,000 cubic feet per minute of dangerous fumes to the atmosphere. That's all we can tell you about them now.

Because Thermix Stacks proved their dependability and efficiency in pre-war work, hundreds of them have already gone into service in war plants. They are doing their part in the gigantic struggle to increase production and to save power, fuel and steel.

Our facilities are devoted entirely to the manufacture of high priority equipment for the war effort.

Catalog No. 109 sent on request.

PRAT-DANIEL CORPORATION

PORT CHESTER NEW YORK

General Sales Agent

Thermix Engineering Co., Greenwich, Conn.

MOVE OR ADD LIGHTS WITHOUT REWIRING—WITH UNIVERSAL Trol-E-Duct

4 BIG HELPS TO PRODUCTION

1 Puts Lights Where They Are Needed—Close to the Work

Universal Trol-E-Duct is a job-proven, modern refinement in factory lighting. Every inch of the duct is a potential electrical outlet which can be instantly tapped to put light close to the work. Simply move the light along the overhead duct, or plug in new lights wherever needed.

2 Always Ready for Quick Production Changes

Universal Trol-E-Duct, built in standard sections, is quickly and easily installed, and can be moved as easily to another location. It is an extremely flexible system — 100% salvable — always ready for quick production changes.

3 Fits Any Production Set-Up

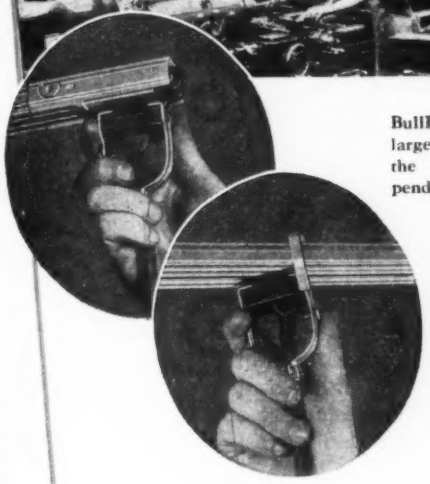
It can be mounted against the ceiling or suspended by messenger cable below it. It will fit the layout of any industrial plant or commercial building.

4 Accomodates Any Type of Lighting Fixture

No matter what type of lighting fixture you use — fluorescent, mercury vapor, or incandescent — Universal Trol-E-Duct can accommodate it because every unit of the system is pre-fabricated at the factory for a wide variety of lighting fixtures.

BullDog's Universal Trol-E-Duct installation in a large midwestern machine tool plant. Note how the closely spaced fluorescent fixtures are suspended and tap current from the Trol-E-Duct runs.

• • •



Extreme Left — Shows how simply the trolley may be inserted at the end of the duct runs. Trolley entrance couplings also make possible insertion of trolleys between sections.

Immediate Left—The Twistout Plug can be used at any point in the duct run simply by inserting it in the duct slot and giving it a 90 degree turn.

BullDog Universal Trol-E-Duct is a lighting system of assembled standard duct sections, tightly and safely enclosing copper bus bars from which trolleys and twistout plugs collect current.

Thousands of war plants, big and small, find this thoroughly modern lighting system an important factor in speeding production by bringing light close to the work.

If conditions do not permit you to change over to this easy, quick, flexible lighting system now, be sure to modernize with Universal Trol-E-Duct before the products of peace go to market again.

Buy More War Bonds — Turn in Your Scrap

BULLDOG

ELECTRIC PRODUCTS CO.

BOX 177, R. PK. ANNEX
DETROIT 32, MICHIGAN
BullDog Electric Products of Canada, Ltd., Toronto, Ont.

Field Engineering Offices in All Principal Cities

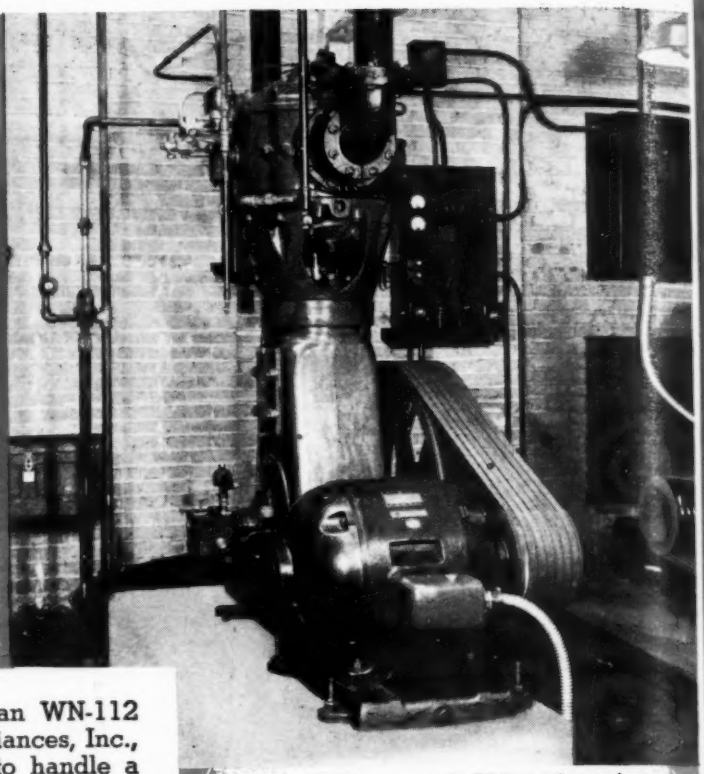
ALSO MANUFACTURERS OF

VACU-BREAK SAFETY SWITCHES • SAFTOFUSE PANELBOARDS • SWITCHBOARDS • CIRCUIT MASTER BREAKERS • BUSTRIBUTION DUCT *for "Plug-in" power* • INDUSTRIAL TROL-E-DUCT, *for movable "loads."*

Long-Life Trouble-Free Sullivan WG-9 Compressor

BOUGHT BY BENDIX

Home Appliances, Inc.



Sullivan WG-9 Compressor for 24 hour a day service. 11 sizes. Capacities 153 to 822 CFM, pressures 30 to 150 lbs.

Following up the purchase of a Sullivan WN-112 compressor in 1937, Bendix Home Appliances, Inc., bought a Sullivan WG-9 Compressor to handle a sandblast load. The plant engineer has this to say: "We won't worry about it if it is built like the WN-112." (That's the point; it is.) "That WN-112 has been running 24 hours a day for the last 7 months; and, except for a man checking the oil regularly, you'd never know it was in the plant."

The WG-9 single-stage double-acting compressor for smaller-demand, heavy-duty service *is* built like the famous Sullivan WN-112. That is to say, every part is built from the best material available *for that purpose,* and is not a compromise. The mirror-honed cylinder and crosshead liners are replaceable *in your plant by your men* and bring back new compressor efficiency after tremendous service. The vital elements such as air passages, valve assemblies, counterweights, etc., are painstakingly engineered by a company noted for the sincerity of its design work. Full force feed lubrication, long-life anti-friction bearings, and maximum capacity per foot of floor space are other reasons why this Sullivan compressor also has established enviable performance records. Don't buy; just INVESTIGATE—thoroughly. SULLIVAN MACHINERY CO., Michigan City, Ind. *In Canada:* Canadian Sullivan Machinery Co., Ltd., Dundas, Ont.

OFFICES:

Seattle	Portland	San Francisco	Los Angeles	Salt Lake City
Boston	Pittsburgh	Birmingham	Duluth	Scranton
New York	St. Louis	Knoxville	El Paso	Denver
Chicago	Detroit	Huntington	Butte	Dallas

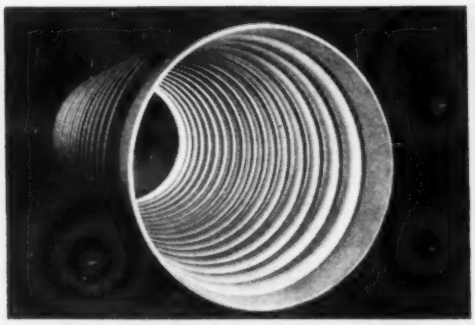
4 THINGS TO MAKE SURE OF WHEN YOU BUY AN AIR COMPRESSOR

1. *Are working parts made of longest-life material available . . . and not a compromise?* Note for example, the generous size WG-9 crossheads tin plated and running in mirror-finish honed liners of tough alloy steel almost obviating wear.
2. *After long service, can working parts be easily replaced to bring back "New Machine Efficiency"?* WG-9 special alloy steel liners can be thus renewed.
3. Are soundest basic engineering concepts followed? How do the valves operate? What about air passages? What is the *truth* about flywheel and pulley wheel combined?
4. Is overall design simple, accessible, yet built to eliminate the usual compressor readjustments? Sullivan users agree that Sullivan Compressors never need break-in adjustments and give least trouble of any.

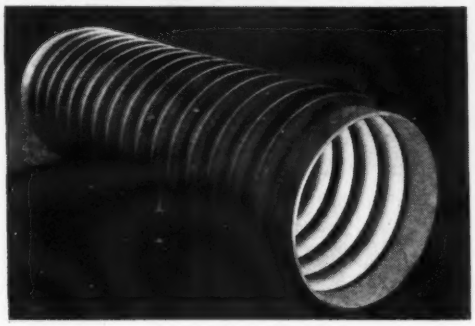
SULLIVAN AIR COMPRESSORS

STATIONARY AND PORTABLE AIR COMPRESSORS FROM ¼ TO 3000 H. P., PNEUMATIC CASTING GRIPS, FOUNDATION BREAKERS, PORTABLE HOISTS, ROCK DRILLS

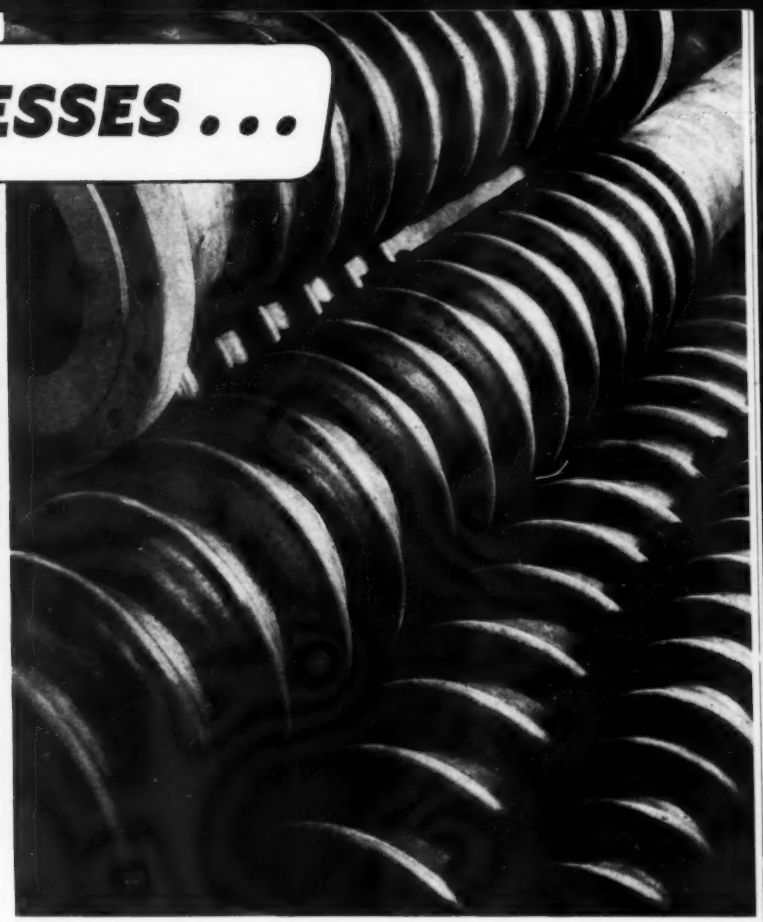
RELIEVE STRESSES . . .



Note Uniformity of Corrugations



24" O. D. by 3/8" Wall



Reduce End Reactions with Pittsburgh Piping and Equipment Company CORRUGATED TANGENTS

PITTSBURGH Piping and Equipment Company Corrugated Tangents are at least 5 times as flexible as a piece of straight pipe of the same length, diameter and wall thickness.

The shape of each individual corrugation with proper spacing is carefully worked out on the correct basis for best operating results. This design is faithfully reproduced with the exacting uniformity necessary to provide even distribution of stresses.

The unusual flexibility of this type of fabricated piping makes possible the use of shorter lines without excessive stresses, strains and end reactions against equipment. It also allows for more convenient location of valves and assures more compact and efficient systems.

Our engineering department will be glad to show you how and where this type of fabrication can be used to your advantage when planning replacements, additions, improvements, or complete new piping systems.

Pittsburgh Piping

AND EQUIPMENT COMPANY

10 Forty-Third Street—Pittsburgh, Penna.

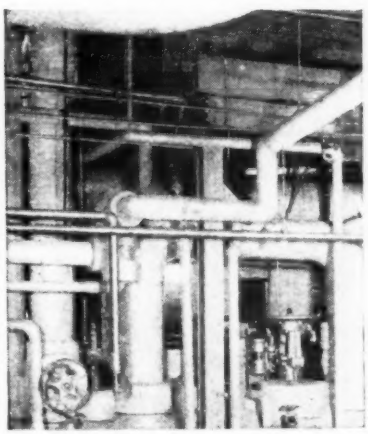
Woolworth Building, New York
Occidental Building, Indianapolis
Book Tower, Detroit
Peoples Gas Building, Chicago
Public Square Building, Cleveland
10 High Street, Boston
525 Market Street, San Francisco

Month after month, America's power plants hang up amazing new records of kilowatt production . . . records which spell ultimate, inevitable DOOM for the Axis!

A large share of the credit for this vastly increased output must go to the nation's power engineers and executives. Almost without exception, these men have wisely insisted on ample reserve capacity, the most advanced, highly developed equipment—and the very best in *heat insulation.*

Their overwhelming choice has been the insulation which for decades has proved its superiority in actual performances—*85% Magnesia.* And many of them, in both public utility and industrial power plants, have specified efficient, dependable, nationally famous

Carey
85% MAGNESIA HEAT INSULATION



Three quarters of a century's experience and long research stand behind this high quality Insulation. Whatever your problem in BTU conservation, it will pay you to get ALL the facts about CAREY 85% Magnesia and other Heat Insulations. Write for details—address Dept. 16.

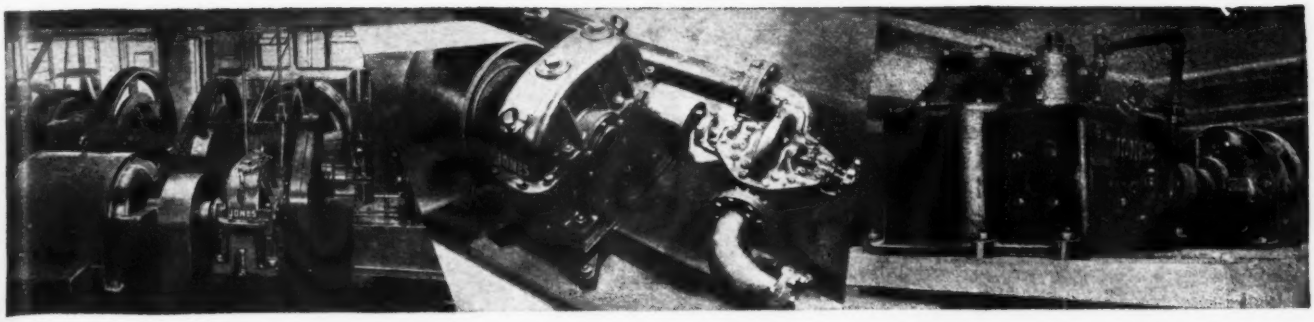
CONSERVE FUEL . . . INCREASE POWER . . . END THE WAR FASTER!

CAREY 85% Magnesia, Hi-Temp, and other Heat Insulations meet every service condition from sub-zero to 2500° F.

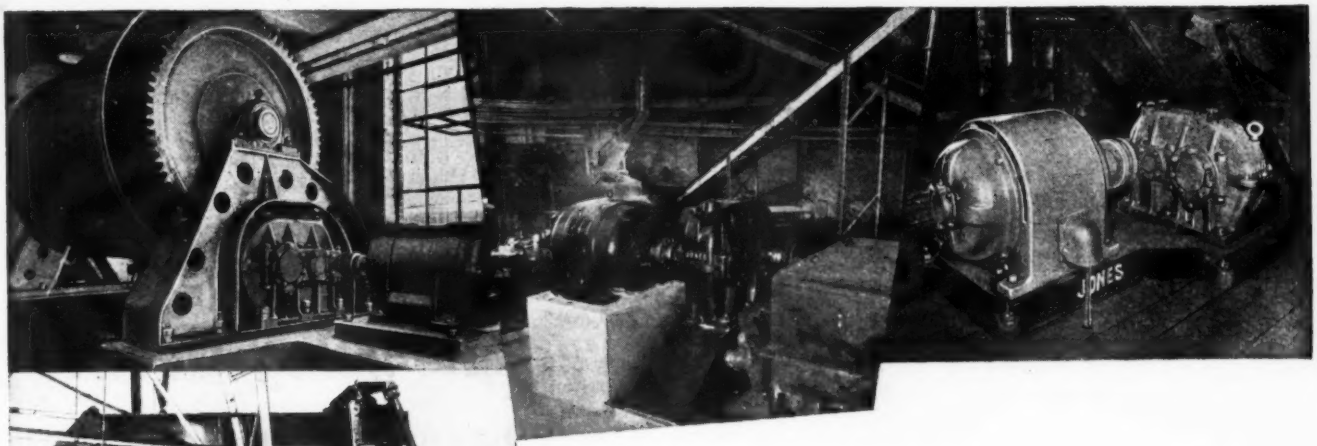
THE PHILIP CAREY MFG. COMPANY—Lockland, Cincinnati, Ohio

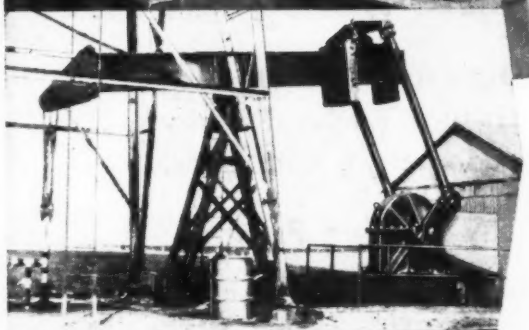
Dependable Products Since 1873

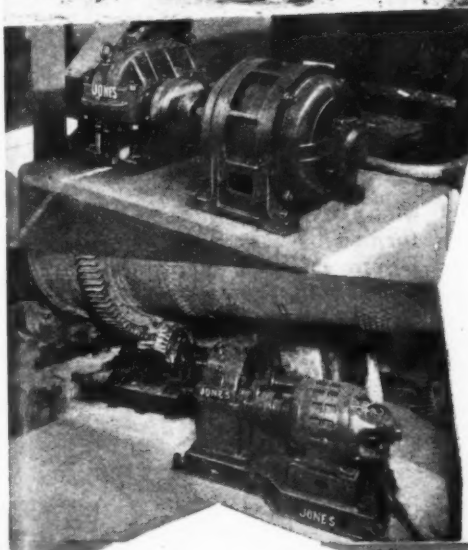
In Canada: **THE PHILIP CAREY CO., Ltd.** *Office and Factory:* **Lennoxville, P. Q.**



JONES DRIVES FOR INDUSTRY







• These illustrations show application of Jones drives to solve a wide range of industrial power transmission problems.

★ For many years the W. A. Jones Foundry & Machine Company has been called upon as a consultant, to help solve a great variety of difficult drives involving the use of speed reducers, gears and other transmission machinery. In many cases these installations have called for the development of special equipment, designed and built to suit the specific requirements of the project.

As a result of these years of experience, involving numerous special problems in the mechanical transmission of power, the Jones organization has collected a vast amount of technical data relating to work in various fields.

Specific bulletins and catalogs are available on the products listed below and a general 20 page bulletin "Jones Drives for Industry" presents a broad picture of Jones products, engineering services and manufacturing facilities.

W. A. JONES FOUNDRY & MACHINE CO.
4423 Roosevelt Road, Chicago 24, Illinois

JUST ASK FOR BULLETIN NO. 80 ➡

Jones

HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS • CUT AND MOLDED TOOTH GEARS • PULLEYS
ANTI-FRICTION PILLOW BLOCKS • V-BELT SHEAVES • FRICTION CLUTCHES • TRANSMISSION APPLIANCES

144 Deming Pumps IN THIS ONE PLANT!

A Deming Pump for Every Pumping Need!

A midwestern steel plant is almost a "living catalog" of Deming Industrial Pumps which are used exclusively for the wide diversity of pumping services involved in the company's operations.

Partial List of Services Performed by Deming Pumps

Cooling Tower service is performed by a battery of high head and low head Deming Centrifugal Pumps.

Slag Breaking is the job of Deming Slurry Pumps which pump cold water on hot slag to shatter it into small particles.

Descaling Billets as they roll from the mills is accomplished by cool water pumped by Deming Turbine Pumps.

Oil Pumping. Fuel oil is pumped from tank cars to storage tanks by Deming Power Rotary Force Pumps. Deming High Pressure Power Pumps force oil thru pipe lines to melt shop and oil-fired furnaces.

Dewatering. Deming Cellar Drainers and Sump Pumps remove waste water and oil which settle in low spots.

Spray Pool service (as illustrated in the above photograph) is handled by a battery of Deming Double Suction Centrifugal Pumps.

Saw Cooling. Deming Centrifugal Pumps supply water to the teeth of steel-cutting saws which require constant cooling while in use.

Many Other Services are performed by a variety of other Deming Pumps in this plant which uses Deming Pumps exclusively.

When YOU have a Pumping Problem — CALL DEMING!

DEMING

THE COMPLETE LINE

PUMPS AND WATER SYSTEMS

The Deming Company • Salem, Ohio

More than 35,000,000 g. p. d.

pure boiler feed make-up are distilled by

G-R BENTUBE EVAPORATORS

This enormous total capacity . . . equivalent to the water supply requirements of a city with a population of more than a quarter of a million . . . and far greater than the total combined capacity of all other evaporator designs on the market . . . is striking evidence of the preference for G-R Bentube Evaporators.

Some of the reasons for this preference . . . proven dependability and economy of operation . . . sustained capacity and maintenance of purity with varying raw water conditions . . . combined simplicity, ruggedness, and accessibility .

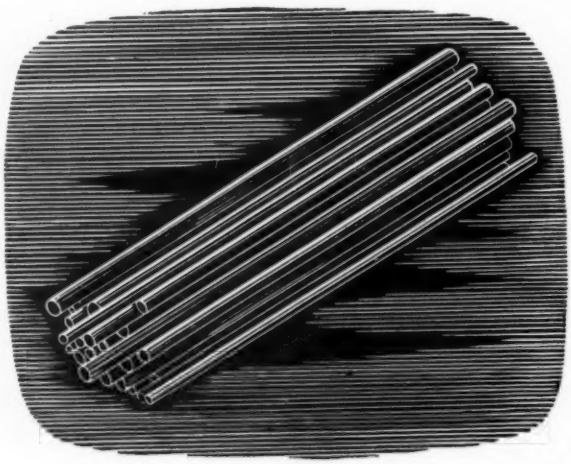
Write for Bulletin 362, which describes in detail the patented scale-shedding elements and other distinctive features of this preferred evaporator.

THE GRISCOM-RUSSELL CO.

285 Madison Ave. New York 17, N. Y.

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus



CONDENSER TUBE

EVAPORATOR TUBE

HEAT EXCHANGER TUBE

WOLVERINE

TUBE DIVISION

CALUMET & HECLA CONSOLIDATED COPPER COMPANY

1411 CENTRAL AVENUE • DETROIT 9, MICHIGAN

In Canada: UNIFIN TUBE CO., LONDON, ONT.

JOHNSON *Automatic* CONTROL

PAYS DIVIDENDS IN . . .
Protecting Health, Assuring Comfort, Saving Fuel

Unerringly . . . day and night . . . in thousands of buildings . . . Johnson precision equipment maintains proper temperatures. Constant vigilance is the watchword!

★ For efficient comfort and good health —
★ For best results in industrial processing —
★ For greater fuel economy —
★ For years of trouble-free service —

Use Johnson temperature control equipment.

No matter what your temperature, air conditioning or humidity control problem . . . get in touch with the Johnson branch nearest you.

Experienced Johnson engineers are available for consultation and to design complete control systems for new and existing buildings.

To keep present installations operating at peak efficiency, Johnson mechanics are ready to make necessary maintenance repairs and adjustments.

Write, wire or phone! No obligation of course.

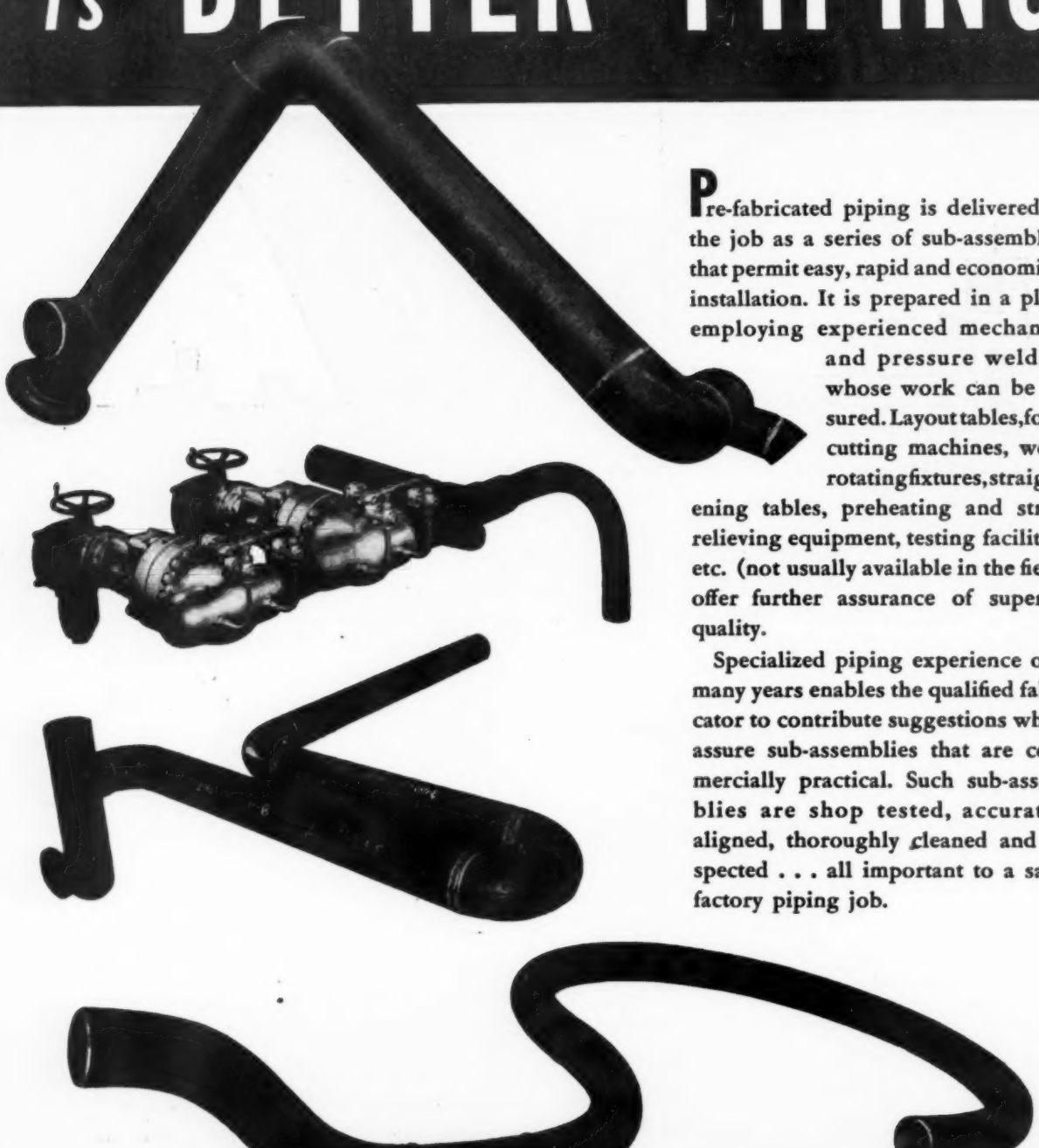
FOR VICTORY'S SAKE
BUY MORE BONDS

Fuel-Saving Starts With CONTROL

JOHNSON Automatic TEMPERATURE AND AIR CONDITIONING Control

JOHNSON SERVICE COMPANY, MILWAUKEE 2, WIS. • BRANCHES IN ALL PRINCIPAL CITIES

PRE-FABRICATED PIPING IS BETTER PIPING



Pre-fabricated piping is delivered to the job as a series of sub-assemblies that permit easy, rapid and economical installation. It is prepared in a plant employing experienced mechanics and pressure welders whose work can be insured. Layout tables, form cutting machines, work rotating fixtures, straightening tables, preheating and stress relieving equipment, testing facilities, etc. (not usually available in the field) offer further assurance of superior quality.

Specialized piping experience over many years enables the qualified fabricator to contribute suggestions which assure sub-assemblies that are commercially practical. Such sub-assemblies are shop tested, accurately aligned, thoroughly cleaned and inspected . . . all important to a satisfactory piping job.

THE PIPE FABRICATION INSTITUTE

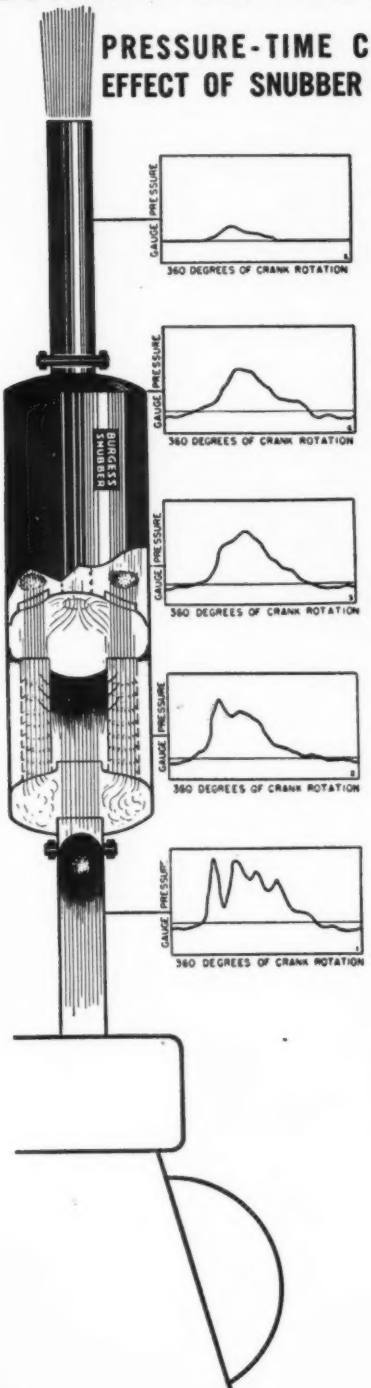
Dedicated to the Technical and Economical Problems of Piping

E-6 1108 CLARK BUILDING • PITTSBURGH, PA.

—ORIGINATORS OF SNUBBING PRINCIPLE FOR QUIETING DIESEL EXHAUSTS—BURGESS—ORIGINA

BURGESS SNUBBER BULLETIN for Diesel Exhaust Noise Control

PRESSURE-TIME CARDS SHOW SMOOTHING EFFECT OF SNUBBER ON DIESEL EXHAUST SLUGS



The source of Diesel engine exhaust roar must be understood before the action of a Snubber in preventing the noise can be appreciated.

One of the characteristics of Diesel engine exhaust is its widely varying range of pressure. With the opening of the exhaust port or valve, burned gas suddenly expands into the exhaust pipes creating a condition similar to an explosion forcing a slug of gas along the pipe, drawing a negative pressure in the end where the disturbance occurred. This is followed by an oscillation of gas in the pipe as it flows back and forth in an attempt to establish equilibrium. Just before the next exhaust impulse, approximately atmospheric pressure prevails at the engine end of the pipe.

The roar of the free Diesel exhaust is caused by unrestrained expansion of these slugs of gas as each is released from the engine under relatively high pressure.

By slowing down the high-speed slugs in a Snubber before they reach the atmosphere the noise is prevented. The slug enters the first section of the Snubber where it expands and loses much of its energy as it passes into the second section. This is a typical snubbing action with the slugs being expanded and their energy dissipated. Each of the other two successive snubbing sections further slow down and dissipate the slug's energy so they reach the atmosphere in a quiet flow, without noisy impact.

The five pressure-time cards shown here were made from practically instantaneous pressure readings obtained over the entire engine cycle with a Sampling Manometer at each of the positions indicated on the Snubber. These readings were taken on a single cylinder Diesel engine firing twenty times per second.

As the slug travels through the Snubber the high initial pressure peak is gradually smoothed down, each section of the Snubber contributing to the process.

The curve in Figure 1, shows that the exhaust is surging back and forth in the exhaust pipe before the Snubber has a chance to break up the slug. The other curves show, that after passing through the first section of the Snubber, there is no negative pressure and that the exhaust gas flows in one direction only. With the flow of gas substantially in one direction, the exhaust system, for practical purposes, ceases to act as an acoustic system.

BURGESS BATTERY COMPANY

announces

Effective February 1, 1944 the activity known as the ACOUSTIC DIVISION OF BURGESS BATTERY COMPANY *will be incorporated as*

BURGESS-MANNING COMPANY

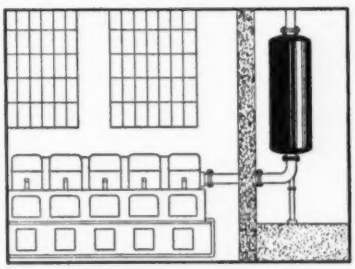
2823-L. W. Roscoe St., Chicago 18, Ill.

This involves no change in personnel or policy

GRAND HAVEN, MICH. MUNICIPAL POWER PLANT

The capacity of this modern municipal power plant was recently increased by the installation of a new 9-cylinder 3859 bhp Nordberg Diesel engine direct-connected to a 3390 KVA, 6900-7200 volt generator. This is the fifth Diesel to be installed in this plant during the past twelve years to supplement a 3,000 KW steam turbine generating plant. The operation of the plant is unusual in that the base load is handled by the Diesel plant with the steam plant serving as stand-by and reserve.

The new engine is equipped with a 32-in. Burgess Exhaust Snubber and a 30-in. Burgess Intake Snubber. The Exhaust Snubber prevents loud exhaust noise while the Intake Snubber prevents the intake noise usually present with large Diesels. This is accomplished by smoothing the flow of intake air without "choking" the intake pipe.



PLANNING FOR POST-WAR POWER PLANTS

Burgess Snubbers can be mounted in any position and will operate with equal efficiency whether they are close to or far away from the engine but there are certain methods of mounting them which are simpler and easier to construct. The method illustrated here is the ideal way to install snubbers for exhaust pipes up to eight inches in diameter. A standard base elbow makes it possible to use the exact length of supporting pipe so that the exhaust pipe can be carried straight out from the manifold to the Snubber inlet.

Published by BURGESS-MANNING COMPANY Chicago, Illinois

COPYRIGHT 1944—BURGESS-MANNING COMPANY

—ORIGINATORS OF SNUBBING PRINCIPLE FOR QUIETING DIESEL EXHAUSTS—BURGESS—ORIGIN
PLETE SATISFACTION IN EXHAUST AND INTAKE QUIETING—SPECIFY BURGESS SNUBBERS—FOR CO

Dodge Transmissioneers Put ALL the Power to Work

Dodge Transmissione*ering* service available through qualified and experienced Dodge Transmissione*ers* in every important industrial center puts all the power into the job with "The Right Drive for Every Job."

Dodge Transmissione*ers* know how to insure continuous low cost operation, increase production and eliminate production delays through application of modern transmissioneering practice which starts with a study of practical production engineering requirements and stops with "The Right Drive for Every Job."

Dodge Transmissione*ers* provide drives assembled from standardized, precision-made parts which in many cases means quick solution of drive problems because of the immediate availability of the necessary equipment from local stock.

Call your local Dodge Transmissione*er*—his service is as close as your telephone.

DODGE MANUFACTURING CORPORATION
Mishawaka, Indiana, U. S. A.

DODGE
The Sign of the Dodge Transmissioneer
"Transmissioneering starts with the study of Practical Production Engineering requirements and stops with the Right Drive for Every Job."

BUY MORE WAR BONDS

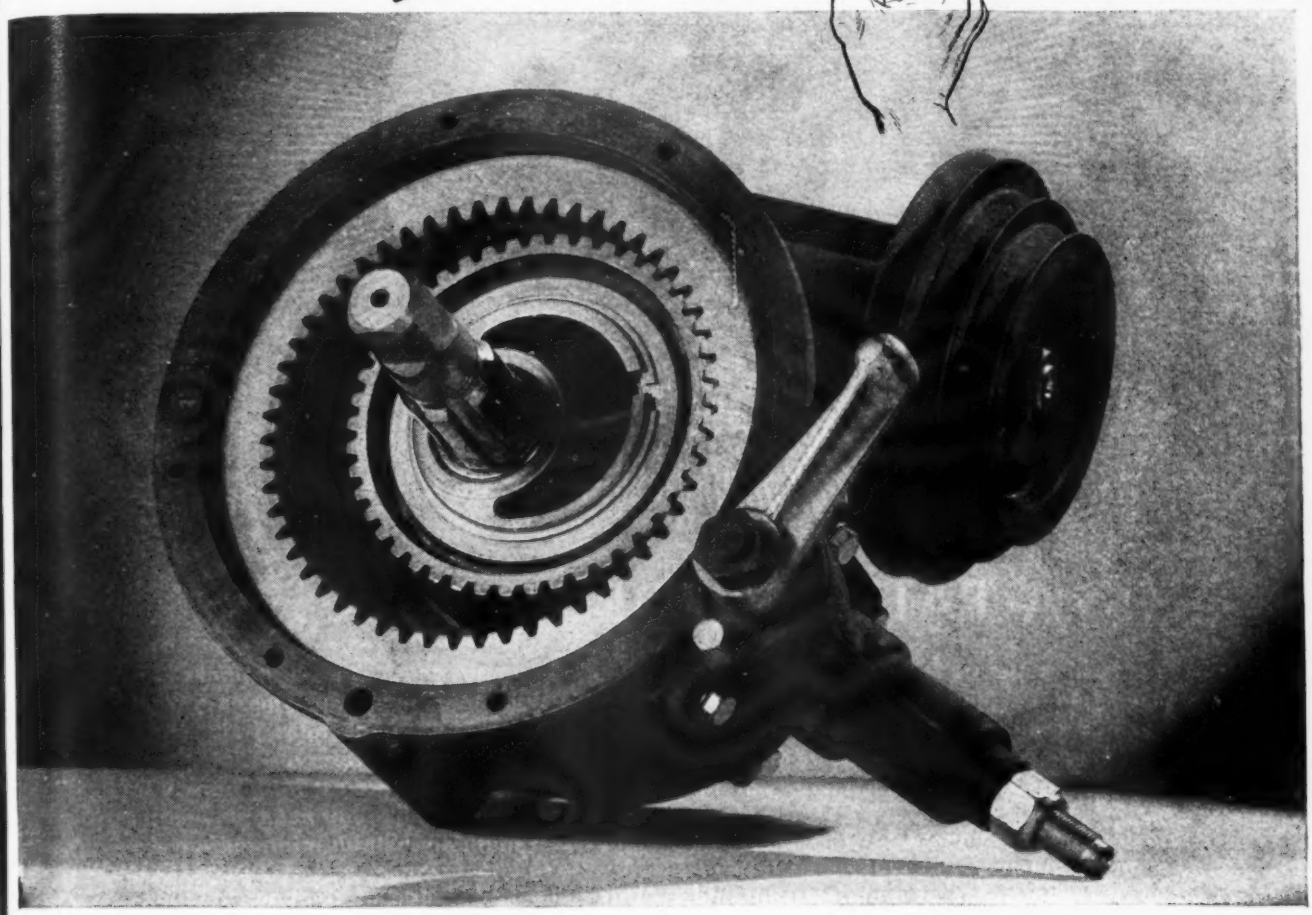
DODGE

Copyright 1944
Dodge Manufacturing Corporation

• • • THE RIGHT DRIVE FOR EVERY JOB

WE ELIMINATED THIS TINY PIN

And changed the Standards of an Industry



In conventional stoker designs the transmission is protected against overload by a little metal gadget called a *shear pin*. In case of a blocked feed screw, the pin is sheared off, thereby disconnecting the motor from the driving mechanism. Until a service man can replace the pin, the stoker is inoperative.

The Winkler Stoker has no shear pin! Its transmission is fully protected against overload damage by the Winkler Safety Release. If an obstruction should block the feed screw, this device automatically and continuously *disengages* and *re-engages* the motor and transmission until the obstruction is removed. The *Winkler Stoker thereupon resumes operation without the need* for service!

Note well the construction of the Winkler Stoker Transmission. The inherent mechanical advantages of *internal planetary gearing* are ingeniously employed to provide a driving unit of extraordinary power. At the same time, this design materially reduces the heavy tooth load which causes rapid wear or breakage..

Winkler Stokers are playing an important role today in the conservation of both manpower and fuel. Your request for further information is invited.

The Winkler Stoker Inter-planetary Transmission—fully automatic and longer-lived.

SEND FOR THIS BOOKLET

The Winkler Engineering Department has published an interesting brochure on the mechanics of inter-planetary gearing as applied to Winkler Stokers. Your request for a copy will be promptly honored.

WINKLER

fully automatic STOKERS

U. S. MACHINE CORPORATION • LEBANON, INDIANA

A PATTERN FOR PROGRESS

It is a basic belief at Thermoid that no one prospers alone . . . that success for worker, owner and customer is interdependent; and that employee welfare is governed by individual striving to advance the interests of all.

This concept of a common good by Thermoid men and women is unusual in so large a group. It is that sense of proprietorship and personal responsibility felt by the employee who works alongside the owner's bench or desk. And it is bred, here at Thermoid, by the same intimate employee knowledge and understanding of the business that unifies effort in the small shop. It is fed by sharing problems and profits.

Speaking to every member of the Thermoid family—in annual reports like the one pictured here—President Schluter gives fullest expression to his belief that "employees do a lot of thinking for themselves; and the more a man knows about the thinking behind his job, the more worthy his work will be."

What Thermoid does . . . what it makes . . . what it sells—and how and where . . . what taxes it pays . . . its wage rates . . . its earnings . . . its dividends and reserves . . . its plans and its problems! All are set forth frankly in the Thermoid Annual Report to Employees as matters of mutually helpful information.

This fuller knowledge of company relationships, with the better understanding of their mutual problems by every worker, is largely responsible for Thermoid's consistent progress. It patterns the cooperation that gets things done RIGHT . . . that causes Thermoid customers to say: "It's good business to do business with Thermoid."

★ ★ ★

THE THERMOID LINE INCLUDES: TRANSMISSION BELTING • F.H.P. AND MULTIPLE V-BELTS AND DRIVES • CONVEYOR BELTING • ELEVATOR BELTING • WRAPPED AND MOLDED HOSE • SHEET PACKINGS • INDUSTRIAL BRAKE LININGS AND FRICTION PRODUCTS • MOLDED HARD RUBBER AND PLASTIC PRODUCTS.

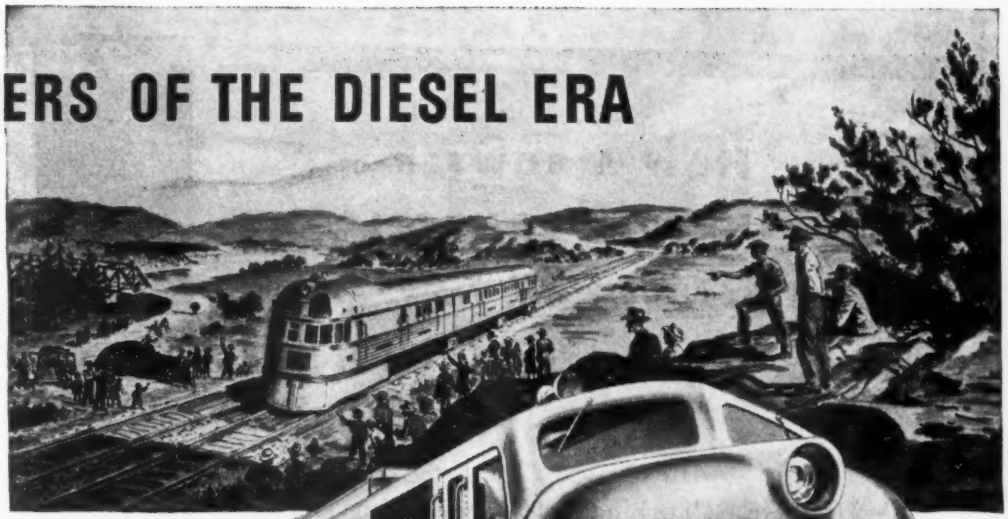
Thermoid Rubber

DIVISION OF THERMOID CO.
TRENTON, NEW JERSEY

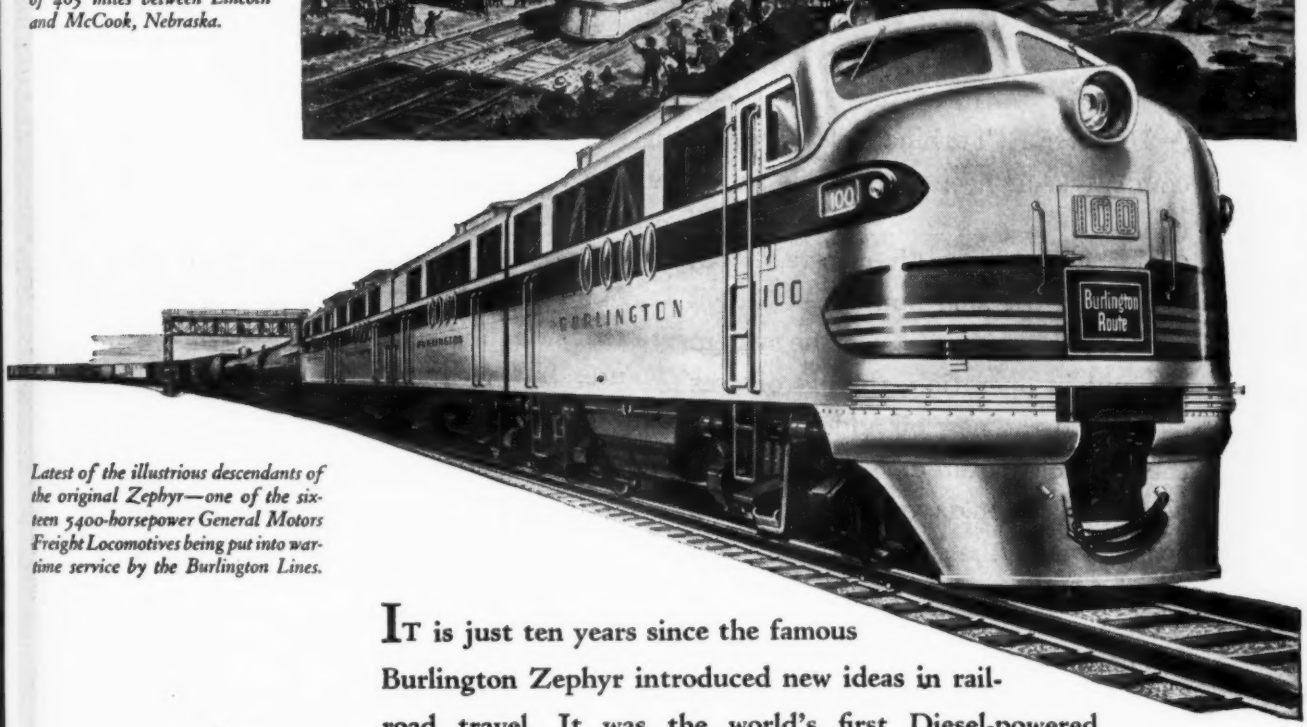
Don't put it off 'til tomorrow—
BUY MORE WAR BONDS TODAY!

It's Good Business to Do Business with Thermoid

PATHFINDERS OF THE DIESEL ERA

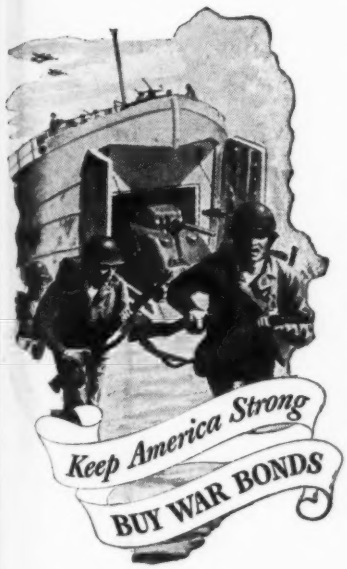


The original Burlington Zephyr which inaugurated a new era in American transportation history in 1934. After more than 1,650,000 miles it still is assigned to its daily round trip of 465 miles between Lincoln and McCook, Nebraska.



Latest of the illustrious descendants of the original Zephyr—one of the sixteen 5400-horsepower General Motors Freight Locomotives being put into wartime service by the Burlington Lines.

IT is just ten years since the famous Burlington Zephyr introduced new ideas in railroad travel. It was the world's first Diesel-powered streamlined train. Its power plant was General Motors Diesel. Today hundreds of General Motors Diesel Locomotives are hauling passengers and freight on 75 American railroads. They operate many millions of miles annually with astounding dependability and economy. Day by day additional GM Locomotives are entering that honored field of more than one million miles of operation. Every day brings new records of performance. And this performance, highlighted by its invaluable contribution to the astonishing war record of the railroads, is providing a glimpse of the greater day of railroading which lies ahead.



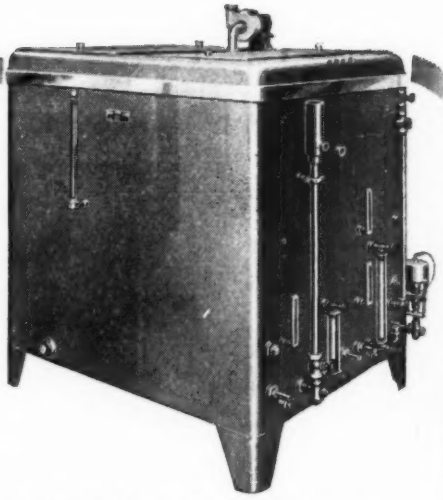
GM
GENERAL MOTORS
DIESEL POWER

LOCOMOTIVES . . . . . **ELECTRO-MOTIVE DIVISION,** La Grange, Ill.

ENGINES . . 150 to 2000 H.P. . . CLEVELAND DIESEL ENGINE DIVISION, Cleveland, Ohio

ENGINES . . . 15 to 250 H.P. . . . . DETROIT DIESEL ENGINE DIVISION, Detroit, Mich.

HOW A BOWSER TURBINE OIL CONDITIONER *Saves Bearings, Oil, Time, Money* FOR A LEADING STEEL COMPANY



A BOWSER Turbine Oil Conditioning System, installed by a leading steel company, has been responsible for these outstanding operating improvements:

- Within ten days after installation, it reduced the acid number of the oil from .0561 to .021. (When the system was put in operation, the old oil was .2512, and the new oil added to meet the system's requirements was .02805. Note that, in ten days, the conditioner even lowered the acid reading below that of the *new* oil.)

- There was only one bearing failure, whereas previously frequent bearing changes were necessary. (The single failure, according to operating records, was due not to lubrication failure, but to impeller misalignment.)

- Only small amounts of make-up oil are added periodically. In several years of operation, it has never been necessary to dump the batch.

- Average oil temperatures in the reservoirs and turbines were reduced 51 degrees, from 185° F. to 134° F.

All of these factors add up to a major saving in time, labor and money. While this particular case history involved a worse-than-average acid condition, Bowser Oil Conditioning assures proportionate results . . . *and savings* . . . in virtually any turbine operation.

The Bowser engineering staff will be glad to consult with you about any lubrication problems. BOWSER, INC., Fort Wayne, Indiana.

Bowser Turbine Oil Conditioners serve all sizes of installations, up to the great utilities plants. They are equally adaptable to all types of steam turbine equipment, including turbo-generators, turbo-compressors, pumps, fans, blowers and other units.

In other phases of industry, Bowser equipment is also serving thousands of companies in the metering, dispensing, storing, filtering and distilling of liquids. Wherever liquids are handled, there's a need for something that Bowser makes.

BUY WAR BONDS

BOWSER ESTABLISHED 1885

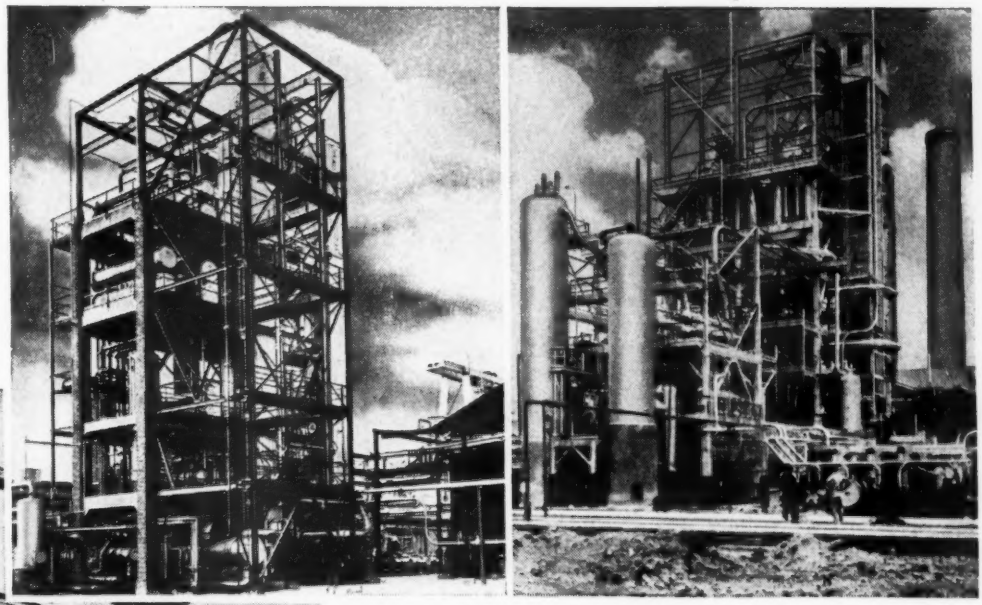
LIQUID CONTROL SPECIALISTS SINCE 1885

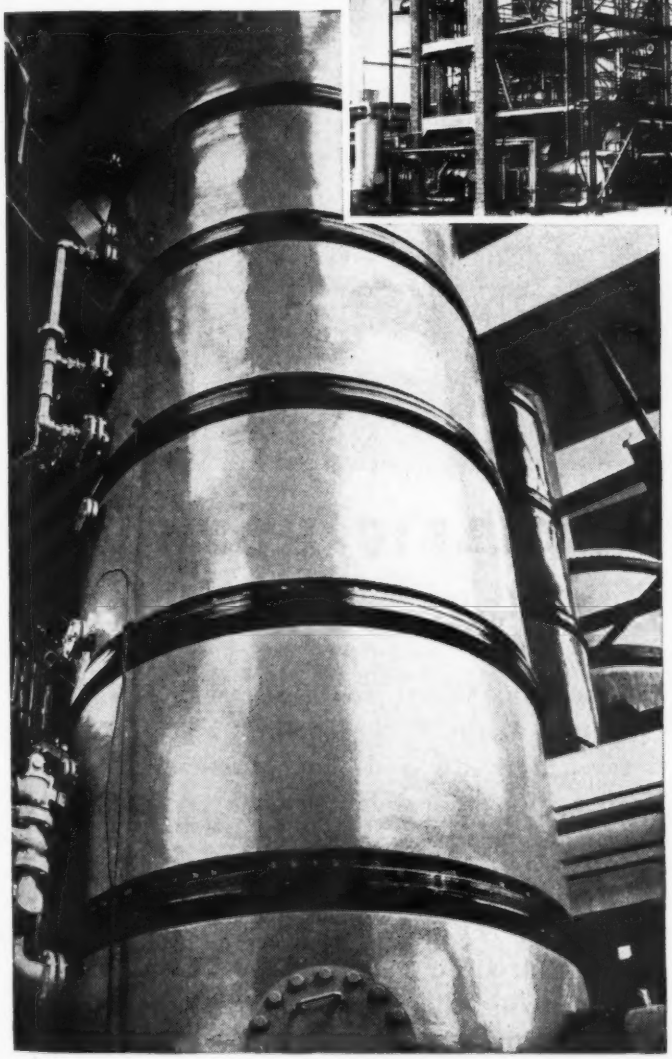
One Answer to the Costly Corrosion Problem

Stainless steel cracking tubes for this refinery unit (near right) resist corrosion, embrittlement, and creep at high temperatures. (Courtesy, The Lummus Co.)

•

Bubble tower (far right) for producing high octane gasoline is lined with 12 to 14 per cent chromium steel to resist hydrogen sulphide corrosion. (Courtesy, The Lummus Co.)





Distillation columns of stainless steel used in the synthetic rubber industry resist the corrosive effect of chemicals and also insure the purity of the chemicals for the synthesis of rubber.

LABORATORY and field tests show that in general the corrosion resistance of steel equipment increases with increasing chromium content.

Stainless steels contain at least 12 per cent chromium. These withstand corrosion from brackish condenser water, and from hot petroleum products that contain sulphur compounds. They resist oxidation by furnace gases, even when under heavy stress. They retain high strength at elevated temperatures. They are wear-resistant.

Because of these properties stainless steels have many applications in the petroleum industry: in tubes of heat exchangers; in high-temperature air preheaters on stills; in flue-gas recirculation systems; in systems removing hydrogen sulphide and mercaptans; in pumps, liners, orifice plates, thermocouple wells, baffles; in furnace tubes and dampers.

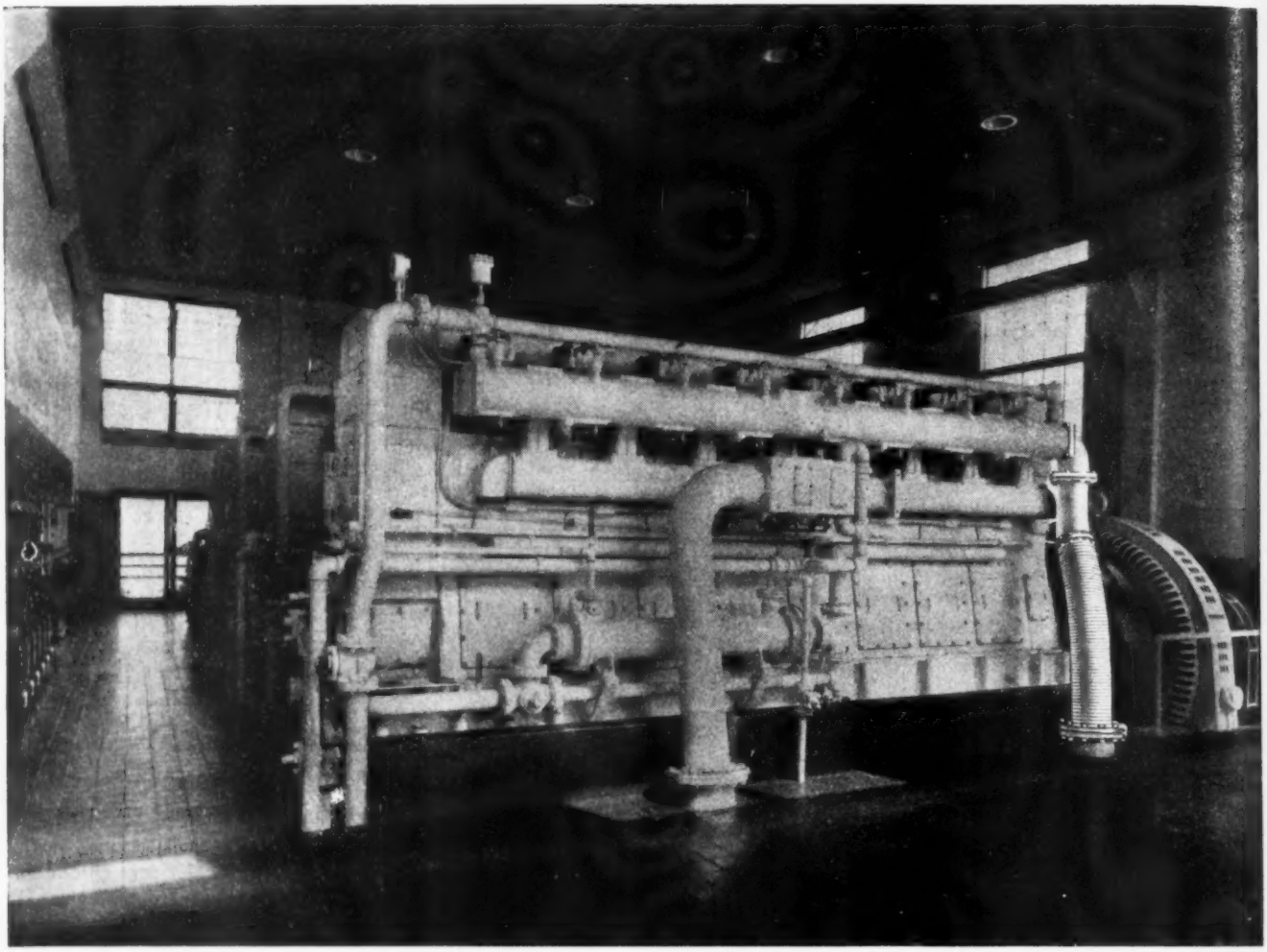
Corrosion resistance—heat resistance—wear resistance—these advantages of stainless steels, so important to petroleum equipment, can be utilized in many other fields. Stainless steels have a unique service record in the tough jobs of industry.

We do not make stainless steel, but we do make ferro-chromium—the backbone of stainless steel. For more than 35 years our metallurgists have studied ferro-alloys and alloy steels in the laboratory and in the field. If you have a question on the selection or use of stainless steel, consult us.

BUY UNITED STATES WAR BONDS AND STAMPS

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

Electromet
Trade Mark
Ferro-Alloys & Metals



PENFLEX FLEXIBLE METALLIC HOSE with

Armored Flexibility for Safety and Service

Important factors in generating power are Service and Safety. That's why PENFLEX is found on many generator sets in power plants throughout the country. PENFLEX with 4-wall interlocking joint construction gives long life and trouble-free service on intake and exhaust lines, oil, water and other connections. It resists thermal and mechanical strains and fatigue; absorbs vibration and provides safety plus economical service.

For fuel oil feed, starting air and manifold drain lines, the corrugated, jointless construction of PENFLEXWELD provides flexibility, expands or contracts easily with changes of temperature, pulsation of pressure, and remains unnoticed because of its almost completely trouble-free service.

Full data on PENFLEX All-Metal Pipes for Diesels in Bulletin 71. PENFLEXWELD is described in Bulletin 90. Write for these Bulletins.

PENNSYLVANIA FLEXIBLE METALLIC TUBING CO.

7238 Powers Lane, Philadelphia 42, Pa.

ESTABLISHED 1902

PRODUCING KILOWATTS ECONOMICALLY

Generator output in many electric plants proves Enterprise Diesel Engine superiority in maintaining high levels of kilowatt production. Built for wide industrial use, Enterprise 4-cycle Diesels are constructed for individual purposes, 225 HP to 2100 HP in three essential sizes, each of which is built in 6 or 8 cylinders. Exhaust gas Turbo-charging provides the higher outputs with exceptional low fuel economy.

Since 1886 Enterprise has engineered meritable equipment for industry

Direct connected, geared or belted to equipment, Enterprise Diesels burn heavy fuel oils with unusual economy. Advanced engineering, embodying wear resistant metals and positive lubrication, results in sustained operation for long continued periods without maintenance or overhaul. Full engine enclosure seals out abrasive dust and grit. Hydraulic Governors provide regulation to meet individual generator requirements.

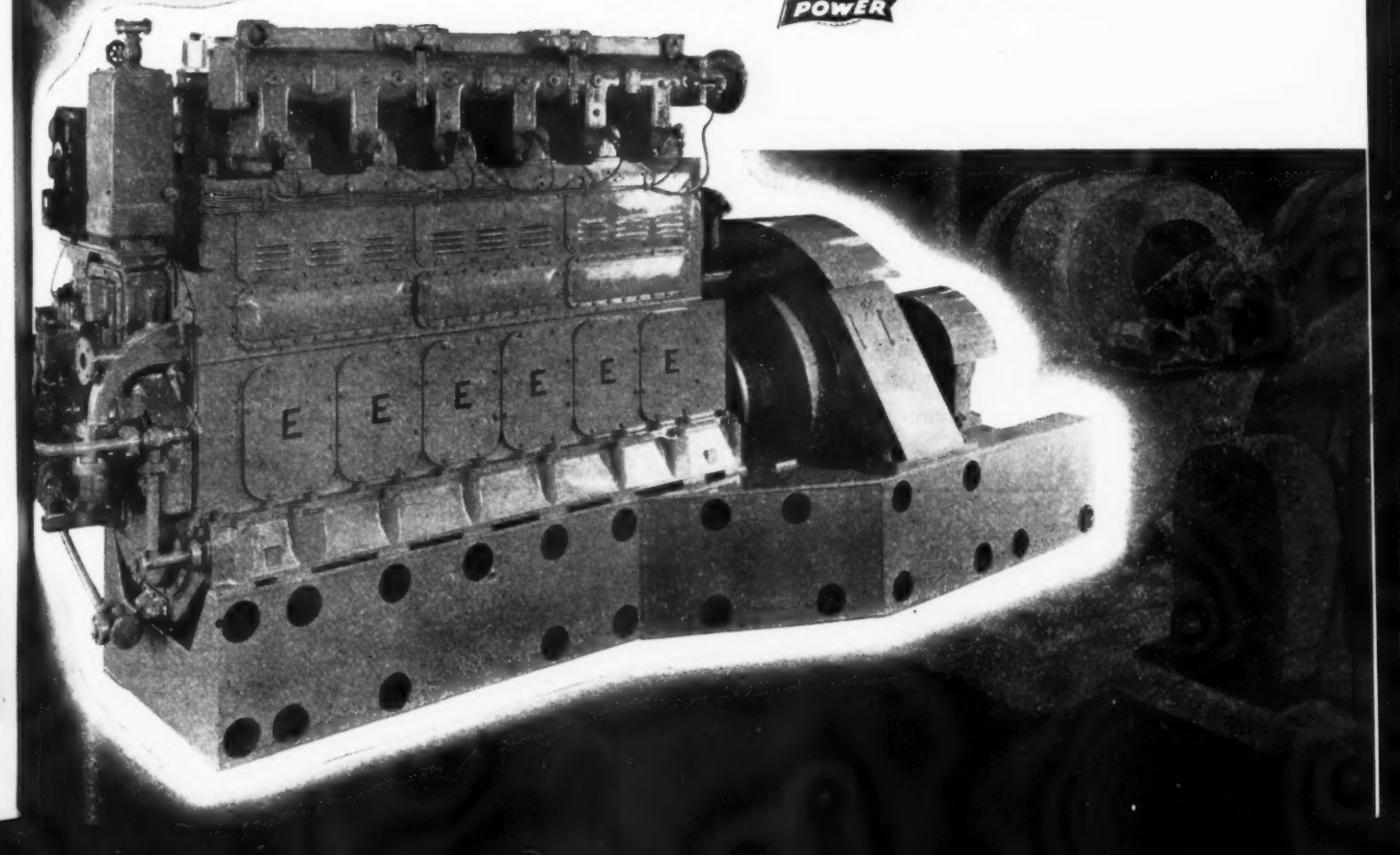
New Illustrated Catalog No. 192 of late models gladly sent on request

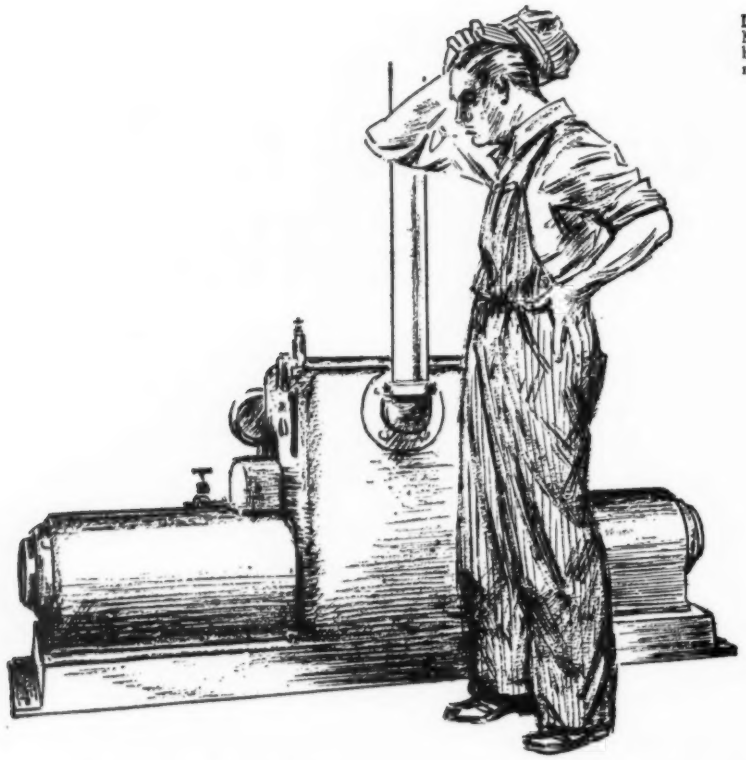
ENTERPRISE ENGINE & FOUNDRY CO.

SAN FRANCISCO
SEATTLE

Enterprise DIESEL POWER

WASHINGTON, D. C.
NEW YORK





Let this be your contribution to Victory: Make your heating equipment serve longer by good care... Conserve fuel by promptly replacing worn-out or inoperative parts.

Having Vacuum Trouble in your Heating System?

If you are having difficulty in maintaining proper vacuum in your heating system (and as a result consuming excessive fuel) it may be due to a number of conditions . . .

1. Make sure that your vacuum pumps are operating properly.
2. Examine piping for "short circuit," i.e., connections that permit steam to pass directly into the returns instead of through the drip trap. Check recent piping changes.
3. Make sure drip traps are operating properly. Check drip points of steam heaters, hot-water generators, mains and risers.
4. Clean priming boilers. Excessive water carried over with the steam keeps drip traps open and prevents building up vacuum.
5. Tighten or replace packing of radiator valves which allow air to leak into the system.
6. Re-evaporation from high pressure condensate discharging into low pressure returns can prevent maintenance of vacuum. Flash tank and float trap arrangements will generally correct this.

Your nearest Webster Representative will help you discover the cause of your failure to maintain adequate vacuum in your heating system. Look in your telephone book, or write us.

Address Dept. P-4

WARREN WEBSTER & CO., Camden, N.J.
Pioneers of the Vacuum System of Steam Heating
Representatives in principal cities : : Darling Bros., Ltd., Montreal, Canada

ARMY E NAVY
Making Boosters for U.S. Army Ordnance

Webster Steam Heating

Webster Suction Strainers are installed ahead of vacuum pumps to keep dirt and scale, brought down with condensation from vacuum system, from damaging pump. Webster Suction Strainers should be cleaned several times each heating season.

PROBLEM: Holding tolerances as close as one millionth of an inch in manufacture of optical ordnance instruments

SOLUTION: Providing constant temperature and humidity conditions to prevent contraction and expansion of materials

Today, the Mergenthaler Linotype Company is concentrating its production on elbow telescopes, battery commander telescopes, panoramic telescopes, aiming circles, azimuth instruments, range finders and other gun sighting equipment for "The Eyes of the Artillery."

Manufacture of such instruments requires the utmost in precision control . . . in some instances tolerances of a millionth of an inch. Without air conditioning such precision would be impossible. Change of temperature and relative humidity, dust or dirt in the air and corrosion-causing moisture *must* be guarded against.

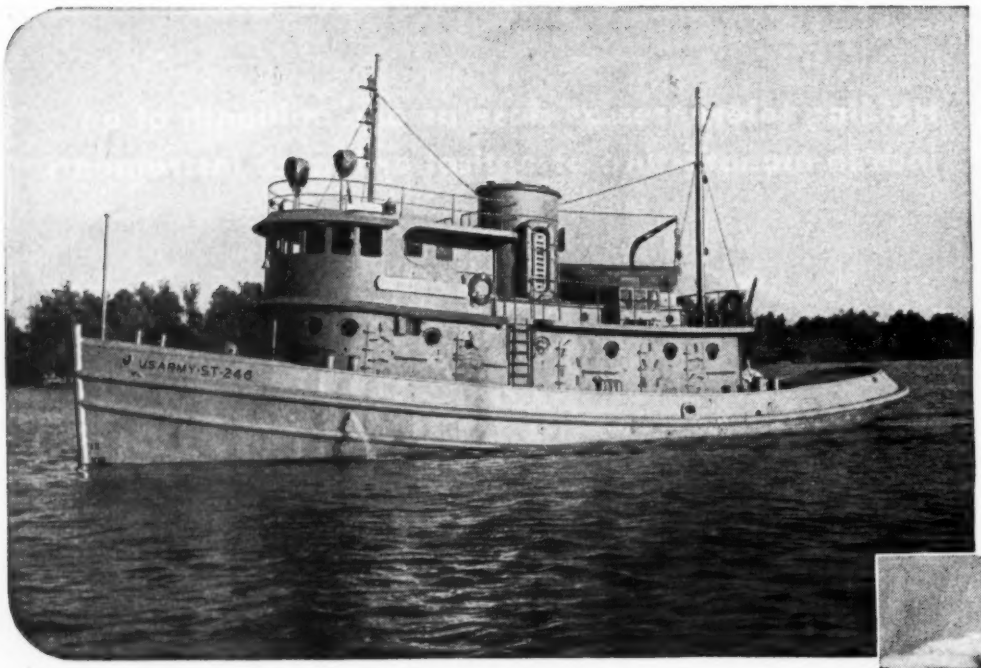
Air Conditioning does just that by maintaining constant temperature and humidity and providing clean, dust-free air throughout this entire modern plant. Today, Carrier centrifugal refrigerating machines supply the essential chilled water for air conditioning and are thereby aiding in the manufacture of many vital war products.

If you are engaged in war production work and have a problem in which control of temperature and humidity are factors, Carrier Engineers will be glad to discuss it with you. Write today to:

CARRIER CORPORATION
SYRACUSE, N. Y.

Carrier
ARMY E NAVY
AIR CONDITIONING • REFRIGERATION

FORTY-TWO YEARS EXPERIENCE IN INDUSTRIAL INSTALLATIONS



Busch-Sulzer Diesels are being installed in Army towboats, of the type pictured (left), used in securing beachheads. The all-steel lighter (below), launched by a St. Louis shipbuilding concern, will be filled with supplies from transports in the war zones and towed ashore.

She Has Something Else In Tow ...SKILL FOR THE FUTURE

To build engines for towing craft like that pictured here ... and other engines for the Navy ... and naval ammunition hoists with watch-like precision mechanism ... we greatly expanded our facilities and increased our trained personnel by 50 percent within the last 18 months.

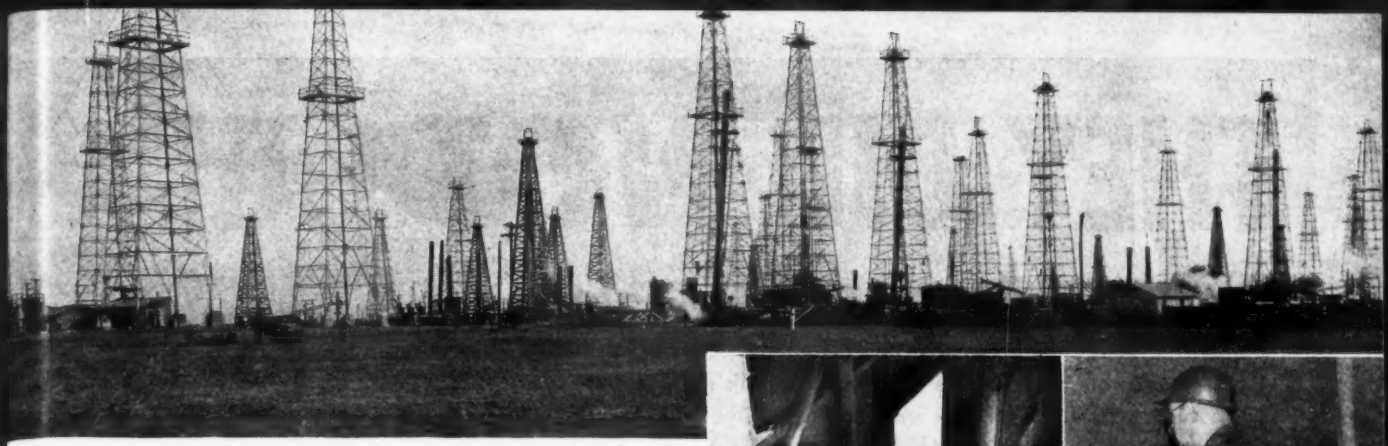
May we suggest that you begin now to familiarize yourself with your postwar requirements and acquaint us with them in good time?

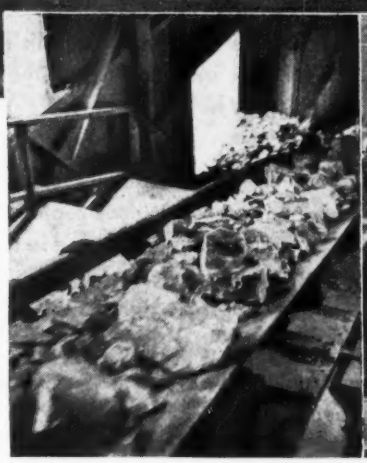
For the last three years, our total output naturally was devoted to orders for the Navy, Army, Maritime Commission and projects connected with the war effort. While the need exists, such work will have first call on our full capacity, but when this demand slackens our facilities and our personnel can be devoted immediately to your requirements. Obsolescence and the need for power in new enterprises plus the fact that many Diesel manufactories in other countries have been damaged or destroyed will result in a huge demand for engines. Your inquiry at this time will enable us to plan so that there need be no delay in filling your needs as soon as capacity is available.

BUSCH-SULZER BROS.—DIESEL ENGINE COMPANY
SAINT LOUIS

AMERICA'S OLDEST BUILDER OF DIESEL ENGINES

BUSCH-SULZER ST. LOUIS





War Service FOR REPUBLIC RUBBER PRODUCTS

On both fighting front and industrial front, numerous rubber products from Republic are in daily service. In America's oil fields, coal and ore mines, quarries and forests, hose and belting speed the flow of materials. Manufacturing and processing industries, transportation, and construction engineering are dependent on many mechanical rubber products. Republic is proud of the contribution to the war program made by its mechanical rubber products.

Accredited Distributor

See your Republic Distributor

WE ARE PARTICIPANTS IN THE OWNERSHIP AND OPERATION OF NATIONAL SYNTHETIC RUBBER CORPORATION

REPUBLIC RUBBER

YOUNGSTOWN 1 • • OHIO

HOSE • BELTING • MOLDED GOODS PACKING • EXTRUDED PRODUCTS

DIVISION OF

LEE RUBBER & TIRE CORPORATION

THEY DID *NOT* FAIL...

In the very foreground of the dramatic production of fighting machines and materials, operate the Public Utilities, supplying power at a rate never before attained. With this in mind it is easy to visualize the LOSS of time and production that can be caused by the failure of a boiler . . . halting generators until boiler tubing is replaced.

Doubly important, therefore, is the quality of boiler tubes in the Nation's power plants. Babcock & Wilcox realizes its responsibility to the war effort. B&W boiler tubes, produced in the world's largest specialty tube mills, are made to give the longest possible continuous service . . . even under pressures as high as 2500 psi, and temperatures up to 900 F.

The unusual boiler problems born of the emergency have yielded valuable new experience which will be available for the development of peace-time industry.

TA-1276

B&W TUBES

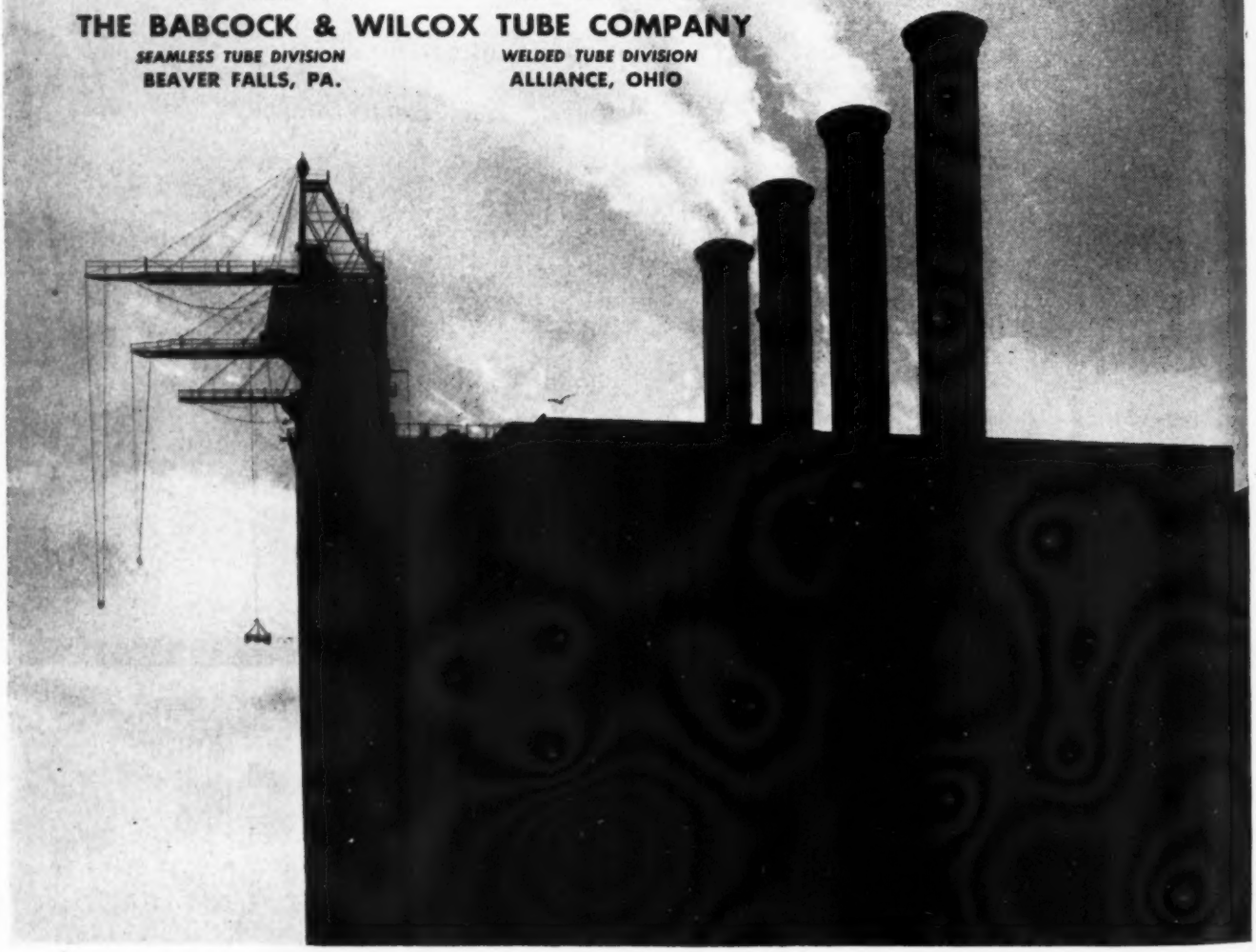
SEAMLESS
Complete range of carbon and alloy steels
Sizes: ½ in. to 8⅝ in. O.D.

ELECTRIC-RESISTANCE WELDED
Carbon grades
Sizes: ¼ in. to 4 in. O.D.

THE BABCOCK & WILCOX TUBE COMPANY

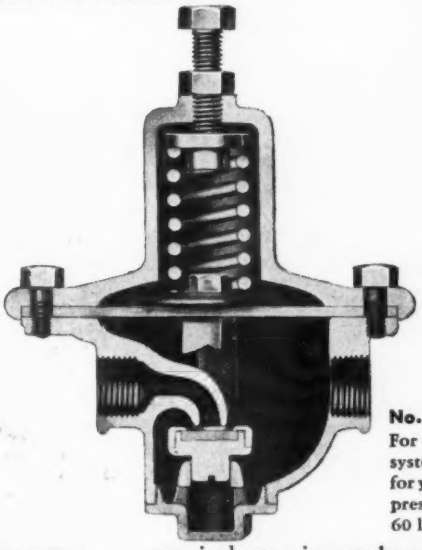
SEAMLESS TUBE DIVISION
BEAVER FALLS, PA.

WELDED TUBE DIVISION
ALLIANCE, OHIO

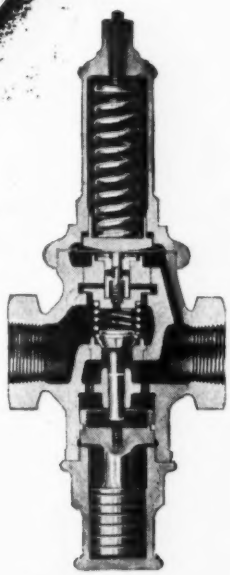


Where Performance Counts **USE MASONEILAN CONTROLS**

MASONEILAN STRAINERS
Prevent scale, dirt, chips, etc. from damaging regulator, traps, valves and pumps with Masoneilan strainers They eliminate maintenance delays and save money.



No. 227
For domestic or industrial water systems. Requires no attention for years. Sizes ¼" to 2". Reduced pressure ranges between 10 and 60 lbs.



No. 11
For reducing steam pressures, Pilot operated. Sizes — bronze up to 2". Reduced pressure ranges between 5 and 225 lbs.

In every type of industry, wherever pressure regulators are used, Masoneilan controls assure dependable and economical operation. They hold pressures exactly where you want them, providing accurate performance under all operating conditions. The thousands of Masoneilan pressure reducing regulators used throughout industry is ample proof of their reliability to give long-lived service.

Some Masoneilan pressure regulators are now available for other than war industries for maintenance and replacement. Write for complete information and catalog 71.

MASON-NEILAN REGULATOR CO.

MASONEILAN

1207 ADAMS STREET, BOSTON 24, MASS., U. S. A.

New York Philadelphia Pittsburgh Tulsa Toledo Chicago Atlanta St. Louis San Francisco Los Angeles Houston Mason Regulator Co. of Canada, Ltd., Montreal

CORRUGATED PIPE
AND BENDS
ADAPTABLE • LESS STRESS • SAVED SPACE
In problems involving high forces or moments due to thermal expansion, Navco Corrugated Pipe and Bends are frequently the only solution.
By reducing the bending stresses and minimizing the end reactions, a safe design is insured which perhaps could not otherwise be obtained.
Whenever you have any unusual Piping problems, consult Navco.
NATIONAL VALVE & MFG. CO., PITTSBURGH, PA.
ATLANTA BOSTON BUFFALO CLEVELAND CHICAGO NEW YORK PHILADELPHIA
NAVCO
NAVCO PIPING

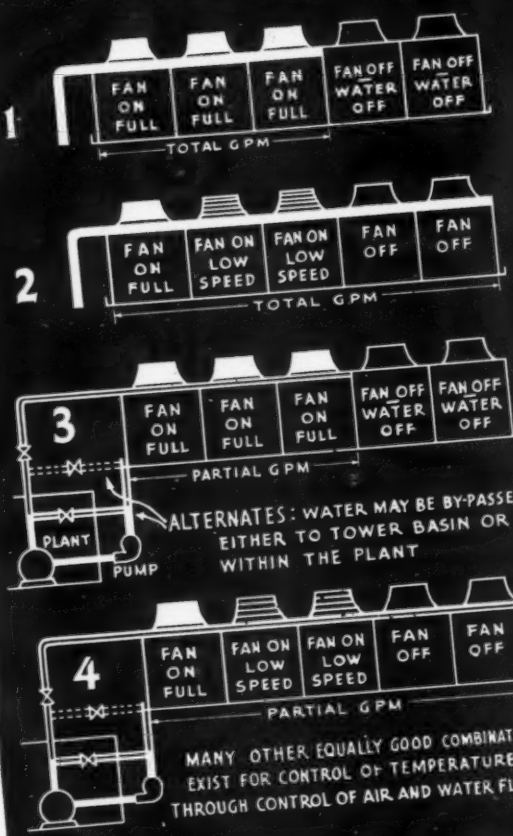
Cooling Tower DOs and DON'Ts

-by MARLEY

(No. 1 of a series)

COLD-WEATHER OPERATION

Trouble-free cold-weather operation can be had with modern cooling towers by proper control and maintenance of air and water temperatures within the tower. Water temperatures in all types of towers can be regulated by (a) utilizing only a portion of the tower, (b) by-passing some of the water, or (c) simply throttling the quantity.



Air flow, which affects internal air temperatures, is difficult to control in natural draft towers but is relatively simple with mechanical draft, particularly if fans have 2-speed motors.

To maintain required temperatures, any of these methods, or a combination, may be used:

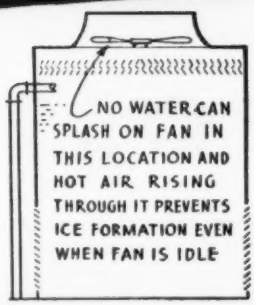
1. *Circulate all the water over only a portion of the tower, shutting down the remainder completely.*
2. *Circulate all the water over the entire tower with all fans idle or any combination with fans at high speed, low speed or idle.*
3. *By-pass some of the water and shut down some sections of the tower completely.*
4. *By-pass some of the water and circulate the rest either over the entire tower or only some sections of it, with fans variously set at full speed, low speed or idle.*

Except in the case of poorly designed towers, good operating practice can avoid "icing" troubles. But should ice have to be removed, thaw it by raising air-and-water temperatures, preferably in one section at a time. If done with hot water or a steam hose, start at top and work down. Induced draft towers can be de-iced by leaving water run and (a) reversing fan rotation if motor and drive permit, or (b) stopping each fan and covering it.

MARLEY COOLING TOWERS

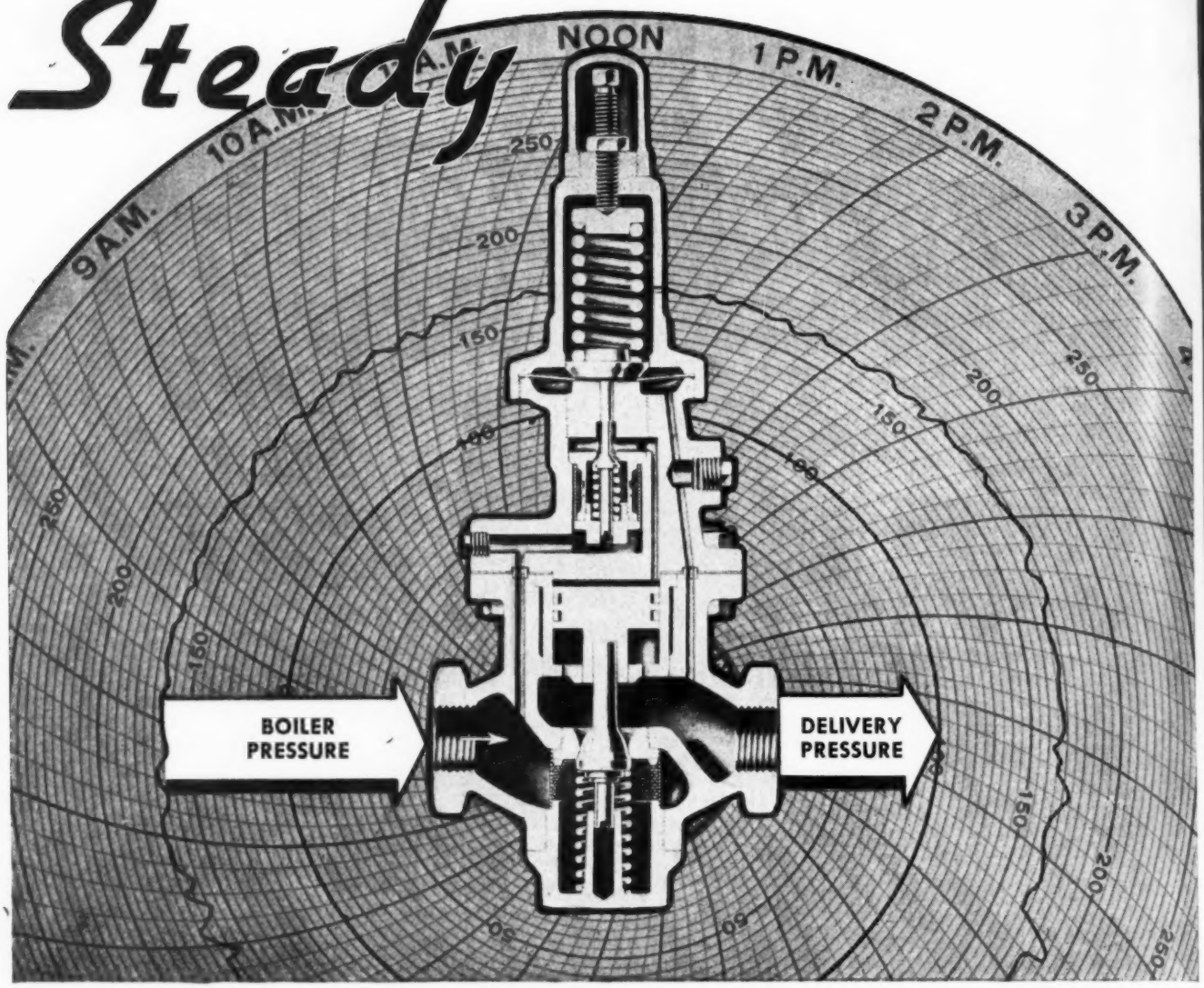
14-A

DO YOU KNOW — that Marley led in developing and advocating the induced draft tower largely because of its all-around operating advantages. Cold-weather features include: 1. Effective performance by natural draft, with fans idle. 2. Only *hot* air passes through fans, keeping them free of ice.



THE MARLEY COMPANY, INC. · KANSAS CITY · KANSAS

Steady



Foster Type 37-G2 Standard Pressure Regulators

- Initial Steam pressures up to 1500 pounds
- Delivery pressures up to 600 pounds
- Total temperatures up to 900° F.
- Auxiliary (or pilot) operated
- Wide variety of spring ranges
- Alloys to suit pressures and temperatures

. . . with minimum maintenance. For instance, in one plant where twenty Foster Automatic Valves have been in service for fourteen years, no major repair jobs have yet been necessary. A few springs and diaphragms have been replaced, and valves have been ground according to schedule—but that's all.

And for *scheduled* maintenance, auxiliary valve units are INTERCHANGEABLE for all Type 37-G2 valves from one half to four inches, which *greatly speeds routine replacements*. Larger sizes also have this feature.

There are many other built in features which provide for quick servicing and checking of parts subject to wear. These features are illustrated in Foster Catalog 70, which also gives you answers to many of your regulation problems. In addition, our engineering staff will be glad to assist you with any *special* problems.

Illustrated catalog on the complete Foster line, with many pages of useful engineering data will be sent if the request is made on company letterhead. Simply ask for Catalog 70.

★

HELP SHORTEN THE WAR
BUY MORE WAR BONDS

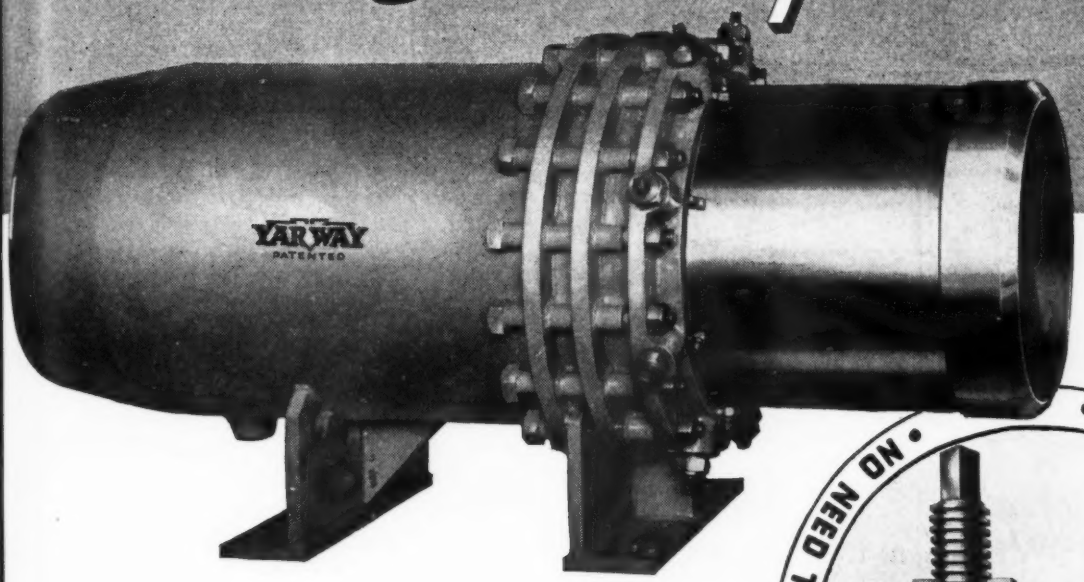
FOSTER ENGINEERING Company

PRESSURE REGULATORS . . . RELIEF AND BACK PRESSURE VALVES . . . AUTOMATIC STOP AND CHECK VALVES . . . ALTITUDE VALVES . . . DAMPER REGULATORS . . . FAN ENGINE REGULATORS . . . PUMP GOVERNORS . . . TEMPERATURE REGULATORS . . . LIQUID LEVEL CONTROLLERS . . . FLOAT AND LEVER BALANCED VALVES . . . NON-RETURN AND TRIPLE DUTY VALVES . . . VACUUM REGULATORS OR BREAKERS . . . SIGHT FLOW BOXES . . . STRAINERS . . . SAFETY VALVES . . . SIRENS

106 MONROE STREET • NEWARK 1, N. J.

4-FE-1

Never Unpacked in Eight Years of Service



Years of experience with thousands of Yarway Gun-Pakt Expansion Joints have established the Yarway as the preference of leading industrials, utilities, institutions and government departments.

For they all have learned that this joint which is packed under full steam pressure and never needs to be unpacked—eliminates repacking shut-downs, saves a tremendous amount of time, trouble, money and hard labor under gruelling temperature conditions, normally required to keep slip-joints tight.

Why don't you investigate the Yarway Gun-Pakt Joint—called "the greatest expansion joint improvement of modern times."

Write for Catalog EJ-1908.

YARNALL-WARING COMPANY
100 Mermaid Ave. Phila. 18, Pa.

The Yarway Gun-Pakt Expansion Joint is the ONLY slip Joint which is packed without unpacking. By a twist of a wrench, a special Yarway semi-plastic packing is forced into the stuffing box by means of integral pressure guns while the joint is under *full steam pressure*. The old packing, rejuvenated by the new, need not be removed.

YARWAY GUN-PAKT EXPANSION JOINT

"BROTHER.. THIS IS NO PIPE DREAM!"

We mean it when we say we fabricate Piping for any purpose... precisely and exactly.

Whether your job be of the simplest design... or as technically complicated as they come, we are equipped to handle it.

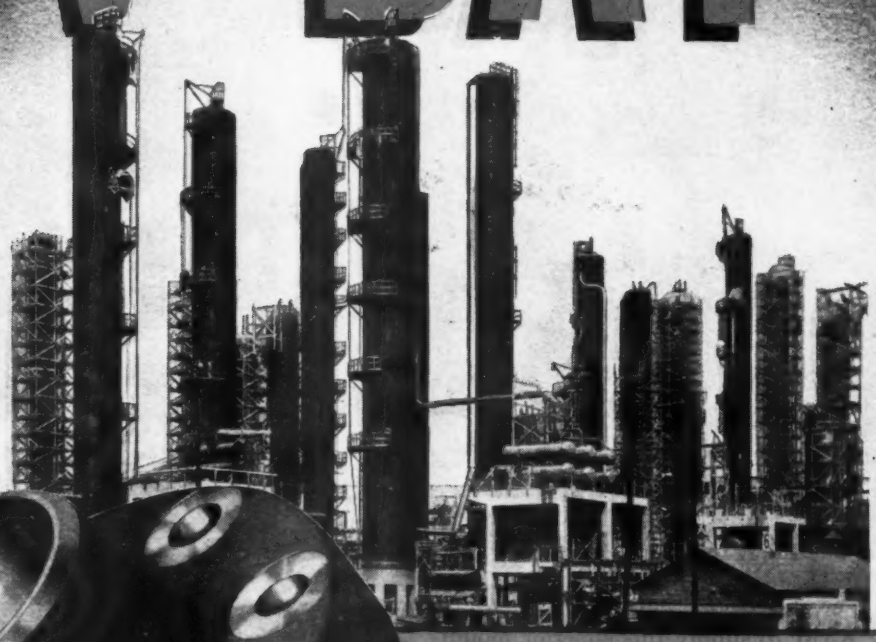
★

HAVE YOU A PROBLEM?
IF IT'S PIPING—CONTACT FLORI!
IT'S OUR BUSINESS TO ANSWER DIFFICULT QUESTIONS WHERE PIPING IS CONCERNED.

FLORI PIPING

THE FLORI PIPE COMPANY, ST. LOUIS — CHICAGO

SPEEDING V-DAY



From butadiene comes the fighting rubber for the battle fronts . . . the cushions for the wheels of industry. In plants like these, devoted to the manufacture of butadiene, Ladish forged steel flanges are doing their part in the development of synthetic rubber —speeding the day of victory.

ARMY E NAVY

FITTINGS DIVISION

TO MARK PROGRESS

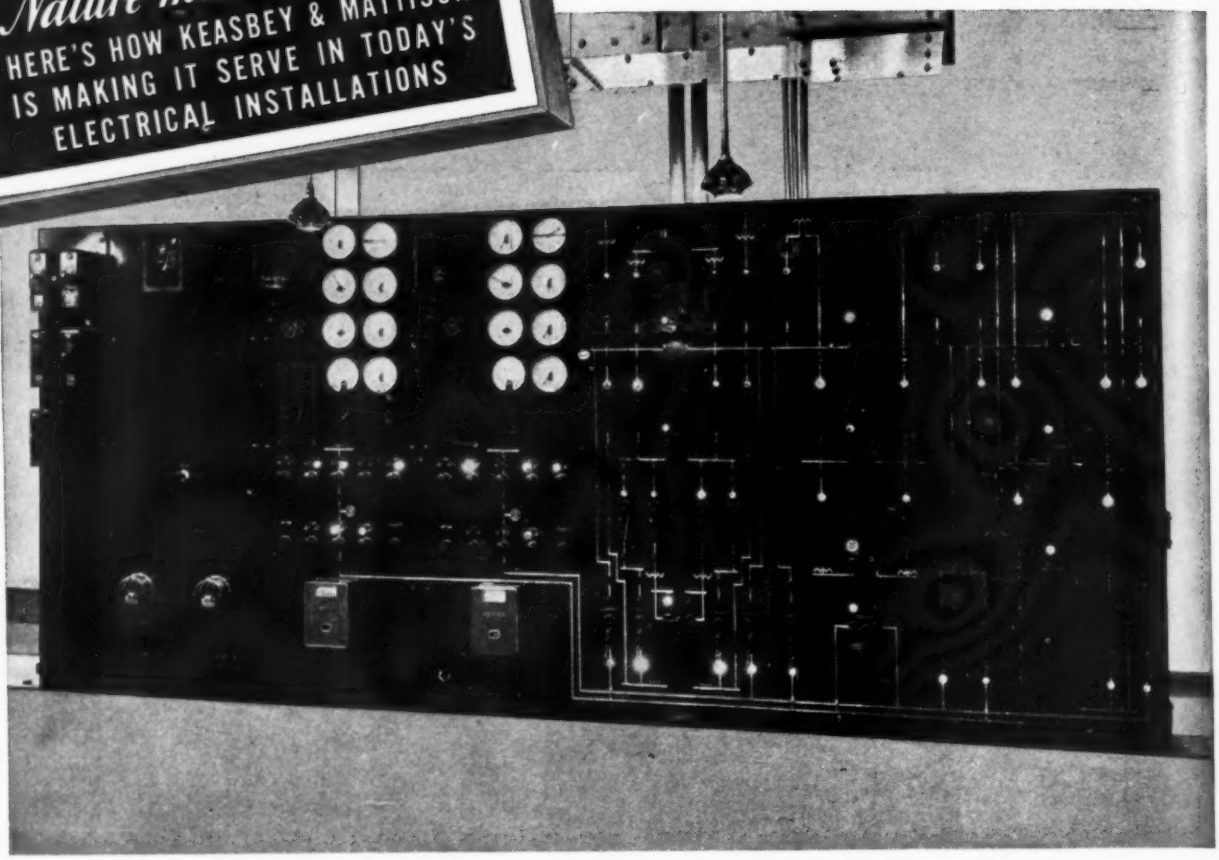
LADISH DROP FORGE CO.

CUDAHY • WISCONSIN

MILWAUKEE SUBURB

Nature made Asbestos

HERE'S HOW KEASBEY & MATTISON IS MAKING IT SERVE IN TODAY'S ELECTRICAL INSTALLATIONS



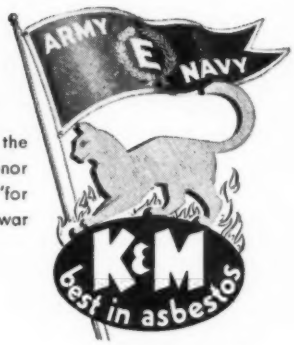
Specially Designed for Modern Insulation Needs . . .

K&M EBONIZED ASBESTOS

Increased production facilities now make it possible for K&M to supply this superior mounting material again. Here is the *ideal* electrical insulation for switchboards, bus bar runs, testing tables, panel boards—designed to meet the most exacting requirements of modern installations.

K&M Ebonized Asbestos is made of asbestos fibre, binding cement and insulating compound —combined in proper proportions and molded into monolithic sheets under intense pressure.

Outstanding advantages of "Ebonized" are its exceptionally high dielectric strength—its ability to withstand severe shock, wide temperature variations and vibration—its resistance to the action of oil and water—and its freedom from shrinkage, cracking and bulging.



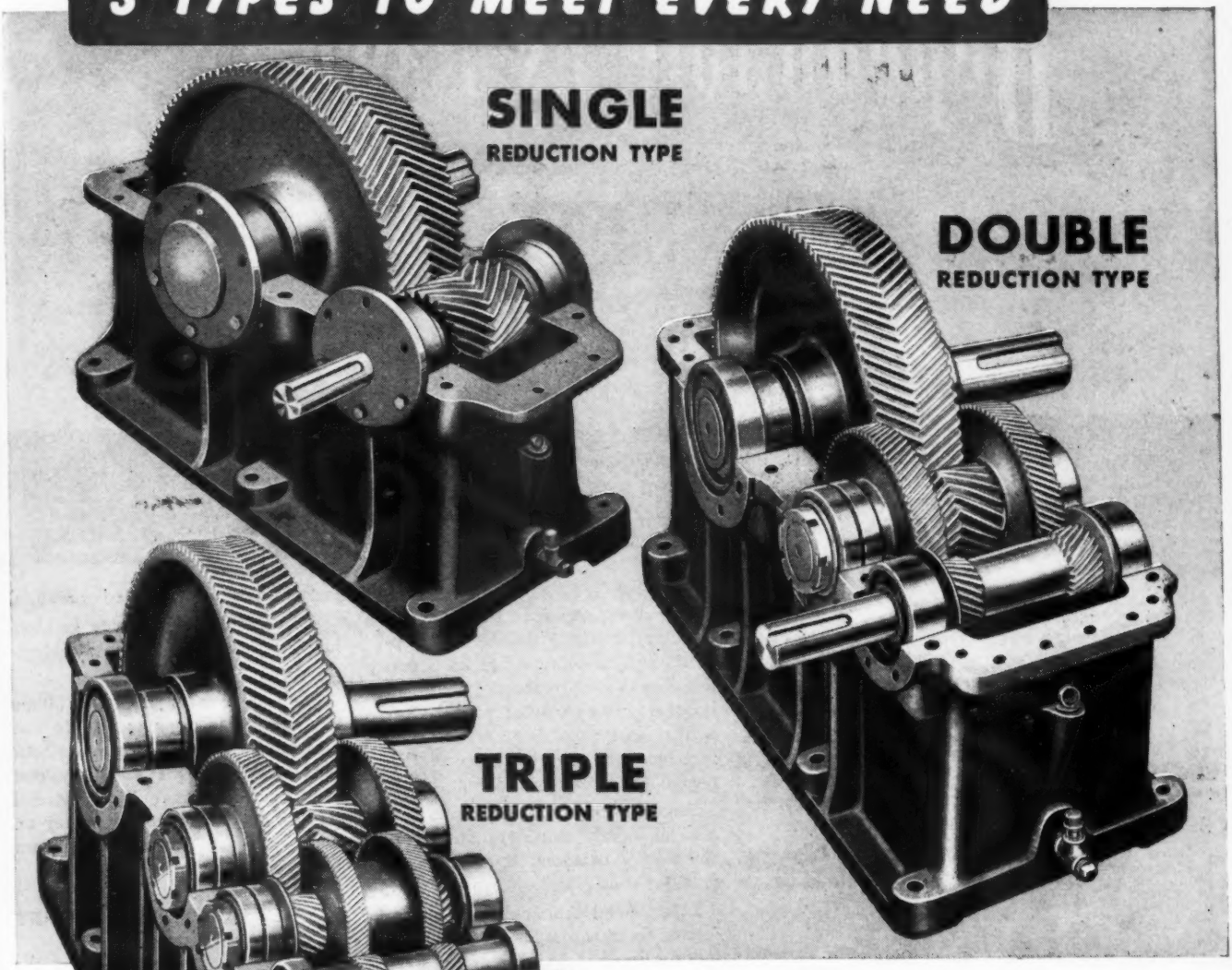
Our Ambler plants proudly fly the Army-Navy "E" flag—an honor awarded K&M employees "for outstanding production of war materials."

With our increased output we can supply you now with K&M Ebonized Asbestos in 1/8 to 4-inch thicknesses, "standard" or special "panel" finish. K&M Ebonized Asbestos meets the technical requirements of the Underwriters Laboratories, Inc., when built into an assembled unit.

KEASBEY & MATTISON

COMPANY • AMBLER • PENNSYLVANIA

3 TYPES TO MEET EVERY NEED



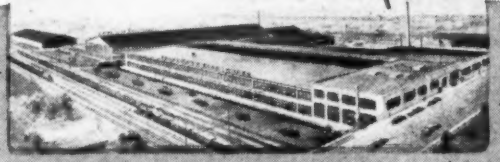
Philadelphia
HERRINGBONE
SPEED REDUCERS

—are built in three general classes, single, double and triple reduction types determined by the number of gear trains used. Each type covers a wide range of sizes and ratios. From this complete line practically any equipment can be provided with the right operating speed, as standard ratios range from 1.75 to 1 up to 300 to 1. These units are also suited for speed increasing.

Helical and herringbone type gears give high capacity and efficiency with smooth tooth action. Symmetrical arrangement of gears reduce shaft stresses and eliminates end thrusts. Pinions are heat treated alloy steel, gears heat treated carbon steel. All shafts are mounted on ball or roller bearings. Efficiencies up to 98% are obtained.

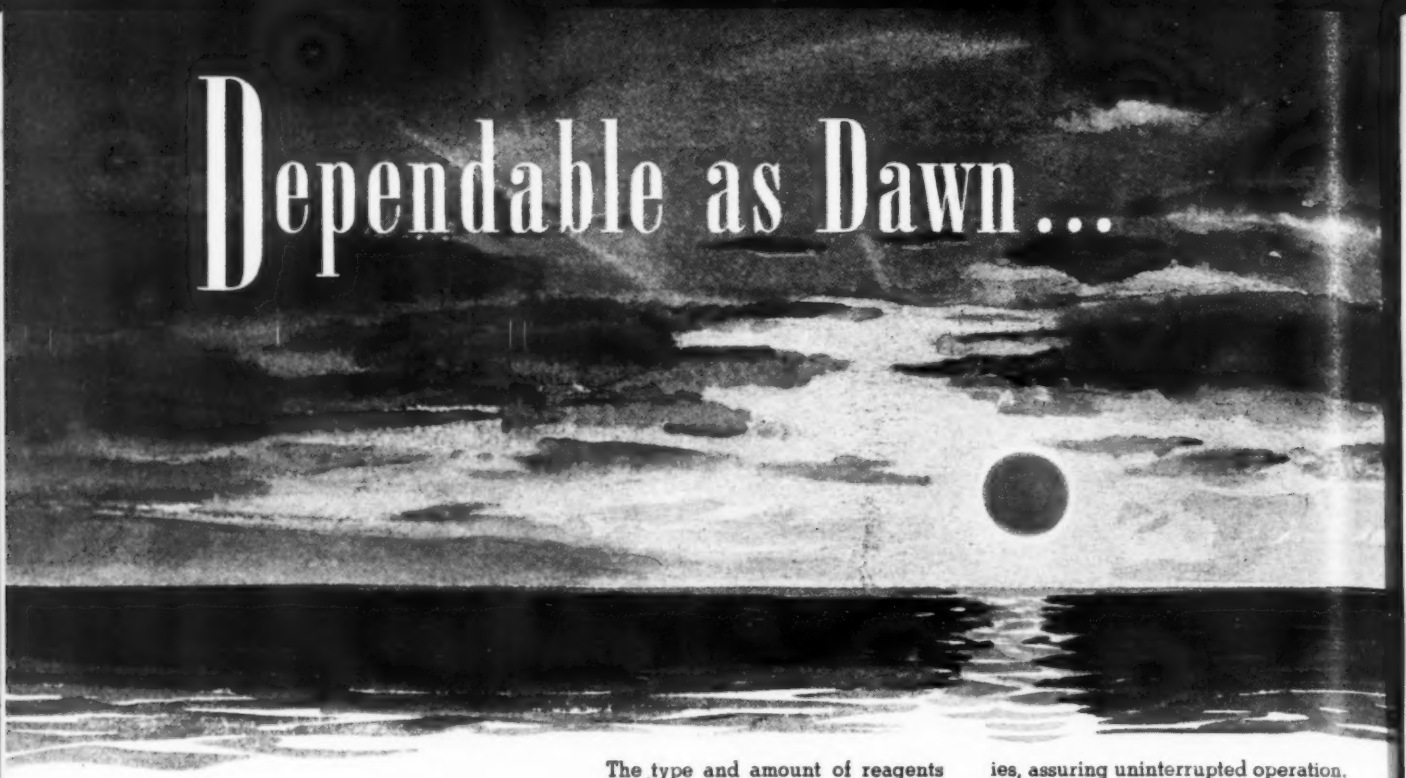
Other outstanding features of these units are explained in our catalog H-39. Write for a copy on your business letterhead.

Philadelphia
GEAR WORKS INCORPORATED
ERIE AVE. AND G ST., PHILADELPHIA 34, PA. NEW YORK • PITTSBURGH • CHICAGO



Industrial Gears and Speed Reducers
LimiTorque Valve Controls

Dependable as Dawn...



Dearborn double safeguards your boilers

The type and amount of reagents required depend upon the complete laboratory analysis of your water supply. The first service Dearborn performs for you is to make a thorough laboratory analysis of your boiler water, and treatment material is recommended on the basis of this particular laboratory analysis.

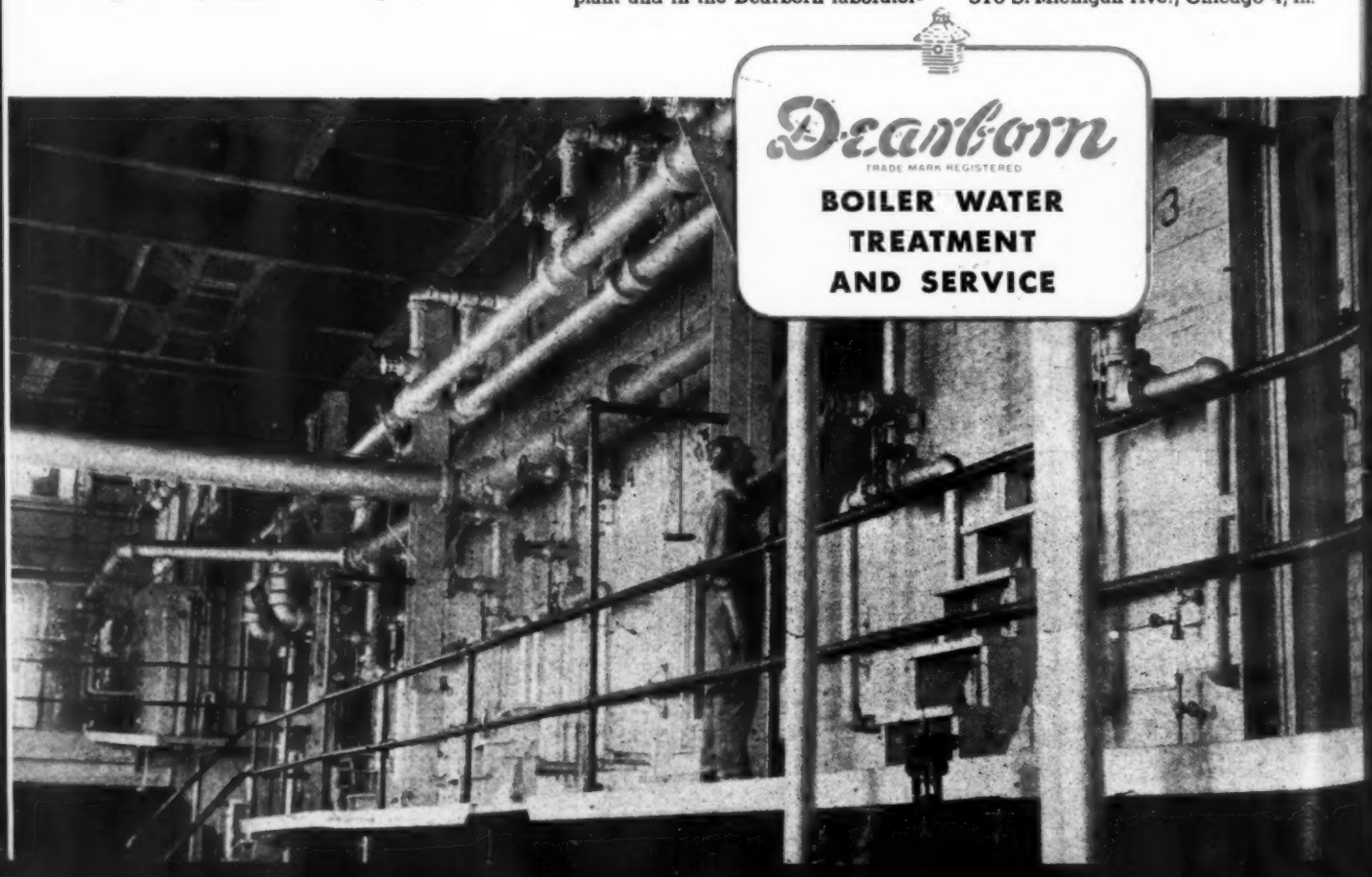
Second, operating conditions are also taken into consideration in formulating a balanced treatment program for your plant.

Experienced chemical engineering service is furnished, both in your plant and in the Dearborn laboratories, assuring uninterrupted operation.

This combination service is absolutely dependable . . . dependable as the dawn!

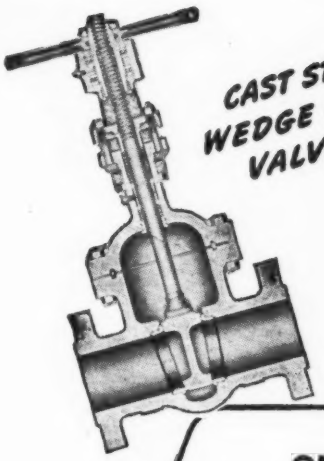
The Dearborn Engineer can initiate this service in your plant. He can invariably point out treatment methods which may not only save you the cost of expensive boiler replacements but also be able to save you money on treatment cost. There's a Dearborn Engineer nearby to serve you.

DEARBORN CHEMICAL COMPANY
Department D
310 S. Michigan Ave., Chicago 4, Ill.

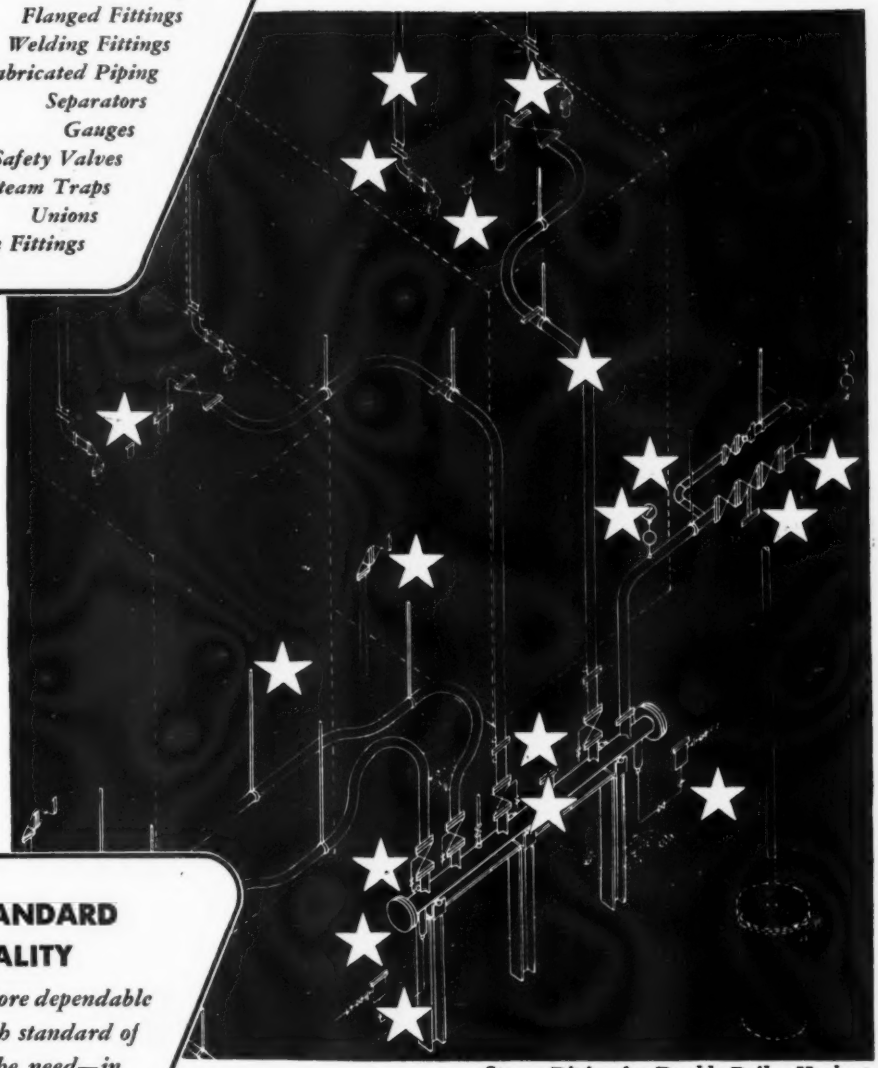


Power or Process Piping Systems CRANE can equip them 100%

Pipe
Pipe Bends, Flanged and Welded
Automatic Stop Check Valves
Pipe Supports
Gaskets and Studs
Gate Valves
Globe Valves
Flanges
Reducers
Screwed Fittings
Flanged Fittings
Welding Fittings
Fabricated Piping
Separators
Gauges
Safety Valves
Steam Traps
Unions
Union Fittings



CAST STEEL WEDGE GATE VALVES



Steam Piping for Double-Boiler Hook-up

ONE STANDARD OF QUALITY

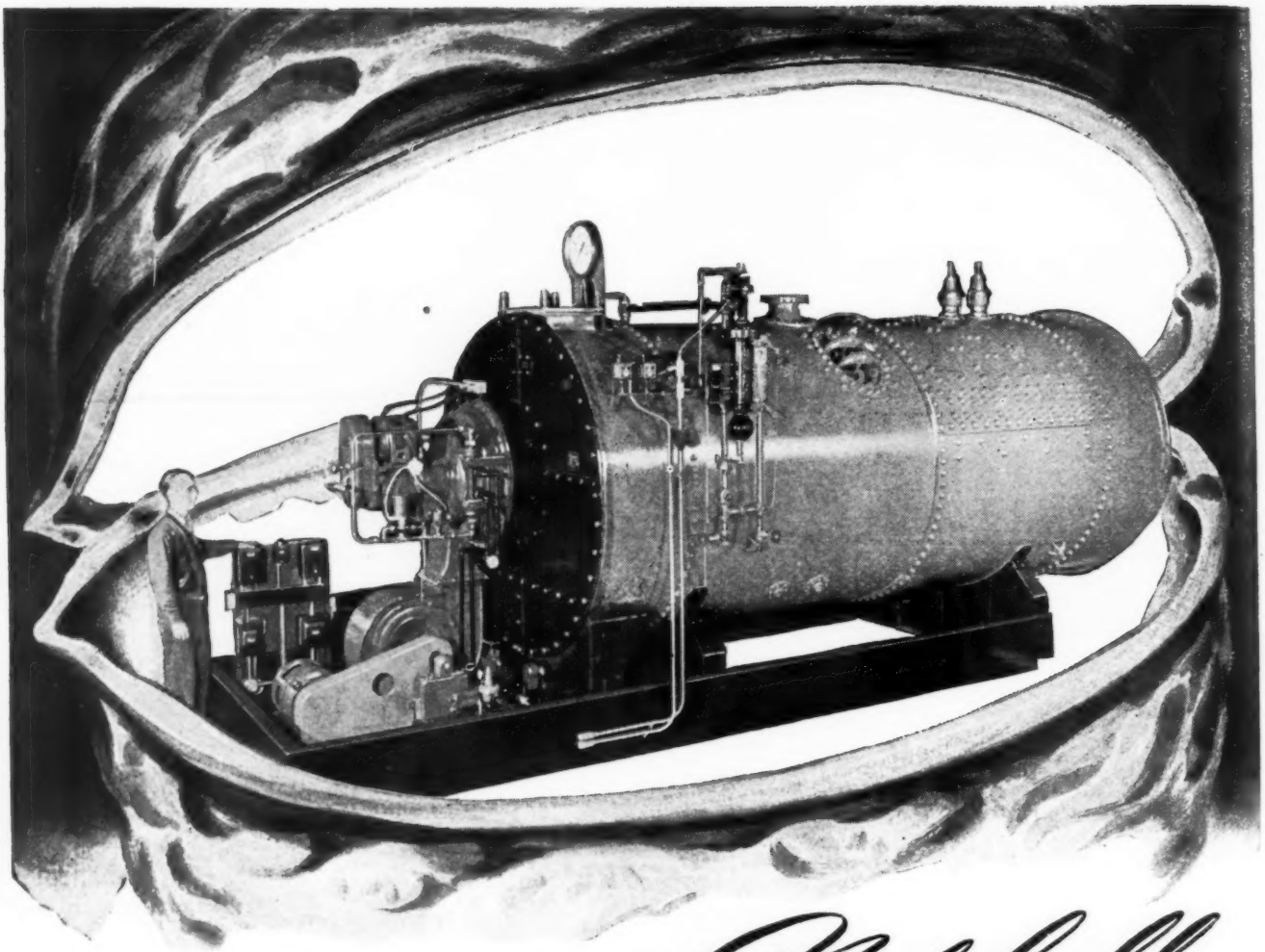
The whole system is more dependable because there's one high standard of quality—adequate for the need—in every part. In Crane Steel Gate Valves, for example: Straight-through ports minimize turbulence, erosion, resistance to flow. Strong tee-head disc-stem connection, ball-bearing yoke, and non-corrosive stem bearings assure smoothest operation. Adequate stem power and extra long disc guides make seating positive.

ONE SOURCE OF SUPPLY . . . ONE RESPONSIBILITY FOR ALL MATERIALS

Only a source as complete as Crane can give you these advantages. For power, process, or any other piping system—not only the valves and fittings, but every part, from pipe to gaskets and studs, are regularly available from Crane. Where else, but in the world's greatest line of piping materials, could you expect a selection of equipment that always meets your needs—of quality that's always dependable? For, back of it stands Crane Co.'s 89-year leadership in the piping field. CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill.

CRANE

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS



A Steam Plant in a *Nutshell*

"THERE it is in a nutshell". . . the most compact means for generating steam for heat, power, or processing . . . the Cleaver-Brooks steam generator.

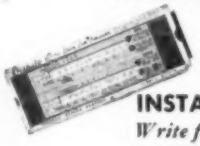
These self-contained steam units are shipped in complete "packaged" form ready to set down on the floor and connect to water, oil, and steam lines. Hundreds of American manufacturers have found it a simple, inexpensive job of installation requiring minimum floor space and room.

Cleanliness in operation is an outstanding feature of the Cleaver-Brooks steam generator. There is no ash, dirt, soot or smoke. The generator runs with almost no attention other than simple routine checking and maintenance.

It is no less astonishing that, in addition to all these advantages of a complete "packaged" unit with minimum space requirements and cleanliness of operation, the Cleaver-Brooks steam generator sets a new high in fuel economy.

The four-pass, fire tube design insures getting the last possible heat unit out of every ounce of fuel. (Thermal efficiency of better than 80% guaranteed.) Steam comes fast and in large volume for the size of the generator — flexible firing rate responds quickly to sudden steam demands assuring a steady pressure throughout the connected system.

In a nutshell, Cleaver-Brooks steam generators give low cost steam with the least demand on the plant operating force for installation, operation, or maintenance. Sizes run from 15 to 500 bhp., at steam pressures from 15 to 200 lbs. sq. in.



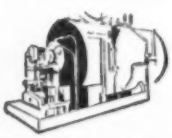
INSTANT STEAM — COST CALCULATOR

Write for this instant steam cost calculator. Yours for the asking. Figures steam costs for oil or coal.

CLEAVER - BROOKS COMPANY
5109 N. 33rd STREET MILWAUKEE 9, WIS.

Cleaver-Brooks
STEAM GENERATORS

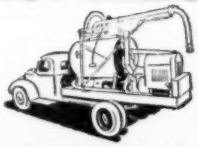
CLEAVER-BROOKS PRODUCTS INCLUDE:



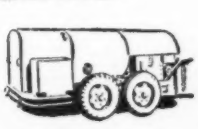
Steam Generators

Food Processing Equipment

Tank Car Heaters



Bituminous Boosters



Special Military Equipment

For Efficiency—
CRYSTOLON Brick

DENSELY constructed of silicon carbide plus a highly refractory bond, and fired at high temperatures, CRYSTOLON Brick perform most efficiently under peak operating conditions. Their dense surface resists slag penetration, making clinker removal easy. They are unaffected by the corrosive action of coal ash slag and will not spall in elevated temperatures.

NORTON COMPANY
Worcester 6, Massachusetts

Norton Longer Lasting **Refractories**

Power Men call it

PAY DIRT

If engines and compressors could digest dirt, power plant men would show even lower costs than they do.

As it is, part of the cost of repairs and parts, of fuel and oil, and of gradually lessening efficiency, must be charged directly to air that carries abrasives and other impurities into the engine.

When intake air is thoroughly and continuously cleaned, engine and compressor life is prolonged, maintenance costs go down, and efficiency stays up.

Looked at it this way, the dirt that filters *keep out* of your machine is real *pay dirt.*

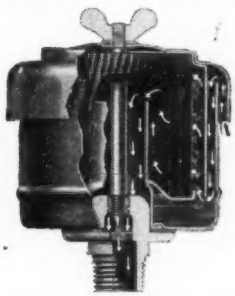
Air-Maze oil bath filters offer high efficiency for this service. Incoming air is reversed to throw out heavier particles. It is scrubbed by oil, and then passes through the viscous impingement filter media.

Oil carried by the air stream continually washes the filter element, carrying collected material to the oil sump. Pressure drop, therefore, does not increase during use, and servicing becomes merely a matter of changing oil occasionally.

Built to *last*, Air-Maze air filters are among that small group of accessories that actually pay for themselves.

Send now for your copy of the new Air-Maze general catalog, AGC-144.

EFFICIENCY STAYS UP!



Explanation:—High velocity air is first reversed, depositing heavier particles in oil. It is then scrubbed by oil, and passes through viscous impingement filter. Oil carried by air stream continuously washes filter element and renews adhesive film.

AIR-MAZE CORPORATION • ***Engineers and Manufacturers*** • **CLEVELAND 5, OHIO**

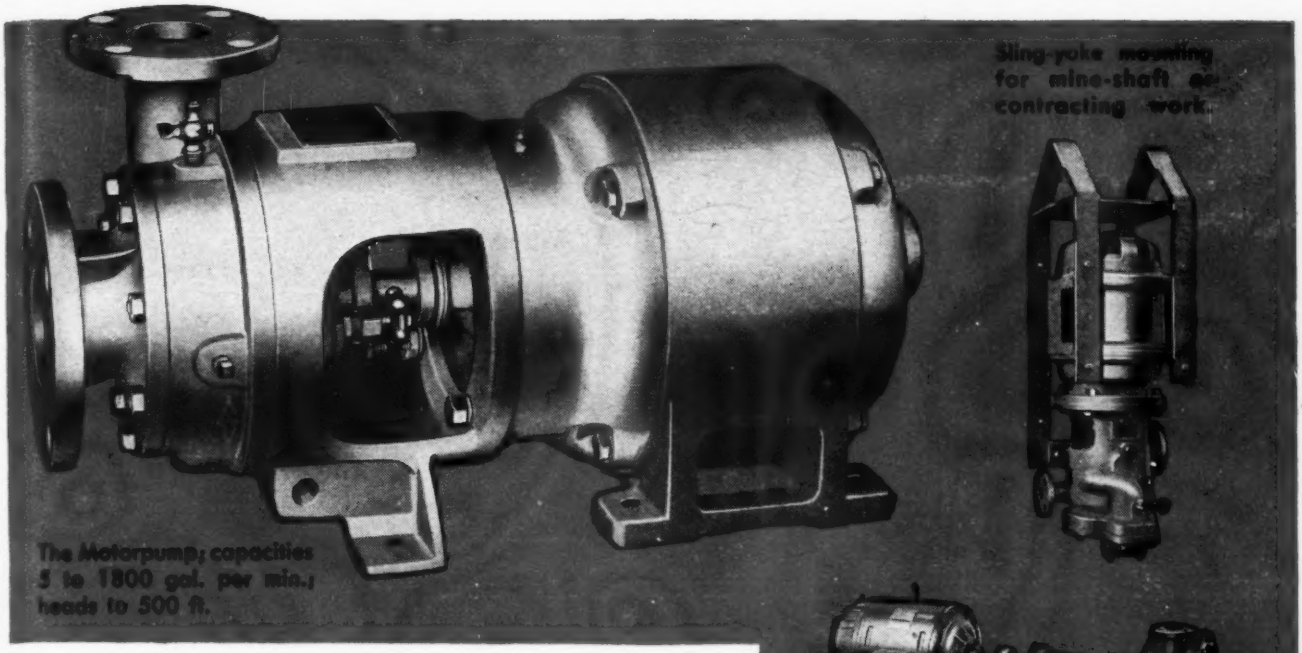
Representatives in Principal Cities • *In Canada:* Williams & Wilson, Ltd., Montreal, Quebec, Toronto, Windsor

ARMY E NAVY

AIR-MAZE

SPECIALISTS IN AIR FILTRATION

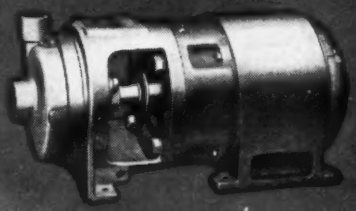
THE MOTORPUMP IS MANY PUMPS



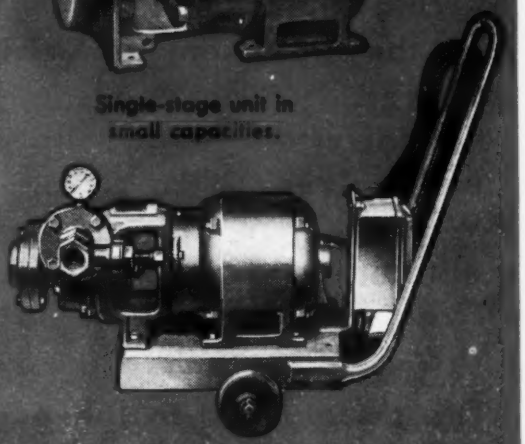
The Motorpump; capacities 5 to 1800 gal. per min.; heads to 500 ft.

Sling-yoke mounting for mine-shaft or contracting work.

Cradle mounting, class CRV.



Single-stage unit in small capacities.



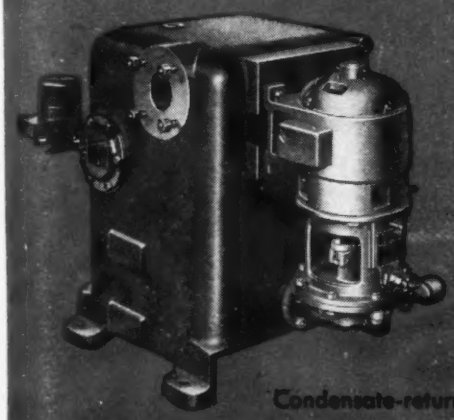
Portable mounting.

..one of them will fit your job

Motorpumps are highly efficient, compact and sturdy pumps. There are sizes small enough to be held in the hand and others to handle as much as 1800 gal per minute. The basic unit has a built-in electric motor. However, various modifications such as built-in steam turbine, cradle mounting for any type of drive, sling-yoke mounting for mine or contracting work and many other mountings and special parts provide pumps tailored to your specific needs. Ingersoll-Rand Company, Cameron Pump Division, 11 Broadway, New York 4, N. Y.

Ingersoll-Rand

9-401



Condensate-return unit.

Ask the I-R Service Engineer for Further Details

Close-coupled turbine-driven unit.

KENNEDY
IRON-BODY WEDGE GATE
VALVES

Convenience Features . . .

- Simple design assures easy, correct assembly.
- Large handwheel for ample leverage.
- Slotted gland top for quick release from stuffing box bolts.
- Shelves on yoke to hold gland well out of way for repacking.
- Swing stuffing box bolts drop out of the way on non-rising stem valves.
- Chain wrench lugs on screwed-end valves.
- Washer type nuts at stuffing box eliminate loss of washers.
- Every bolt accessible to a standard open wrench.

The metal used in these valves is 50% stronger than ordinary cast iron...one of many other Kennedy Iron-Body Wedge Gate Valve features. Catalog upon request.

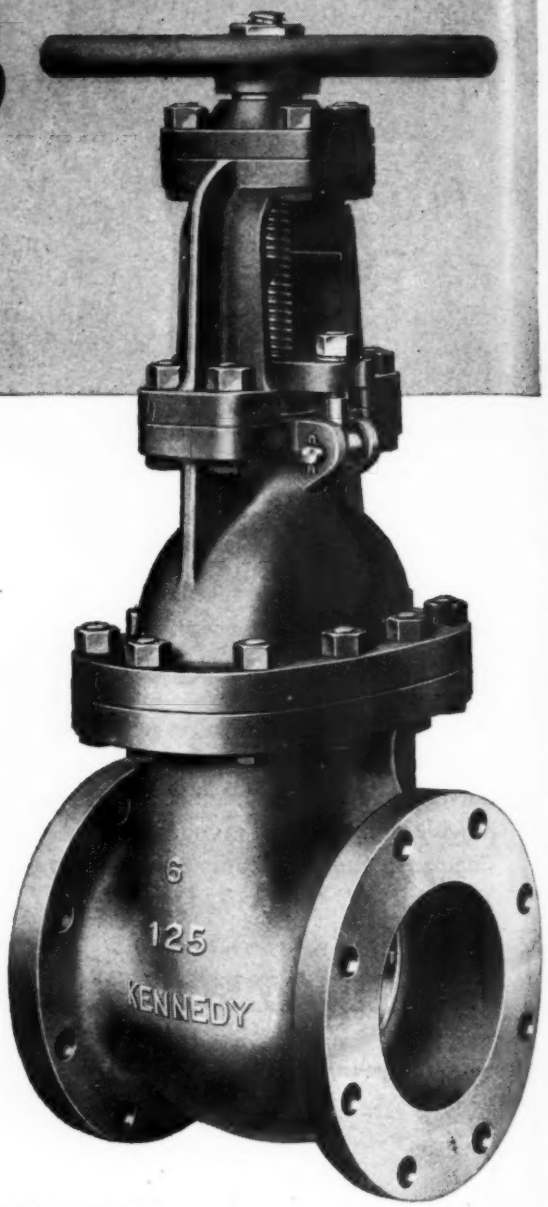


Fig. 061
Standard Flanged O.S. & Y
Iron Body Wedge Gate Valve

THE KENNEDY VALVE MFG. CO. • ELMIRA, N.Y.

SAFE CONDUCT FOR POWER

Medart S-S Type Pillow Block Equipped with Timken Bearings.

Transmission units equipped with Timken Tapered Roller Bearings keep power flowing smoothly from source to point of application. There is no friction, therefore no resultant power loss.

Shaft wear is prevented because all movement takes place *within* the Timken Bearings themselves. Thrust, as well as radial loads —and all combinations of both—are carried with constant sureness. And because the bearings are so completely enclosed and so thoroughly sealed, lubrication is greatly simplified and economized. Dirt cannot get into the bearings; lubricant cannot get out.

All these advantages combine to prevent involuntary power interruptions; reduce power and maintenance costs; and eliminate product loss through damage caused by lubricant leakage. Specify Timken Bearing Equipped line shaft hangers and pillow blocks. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

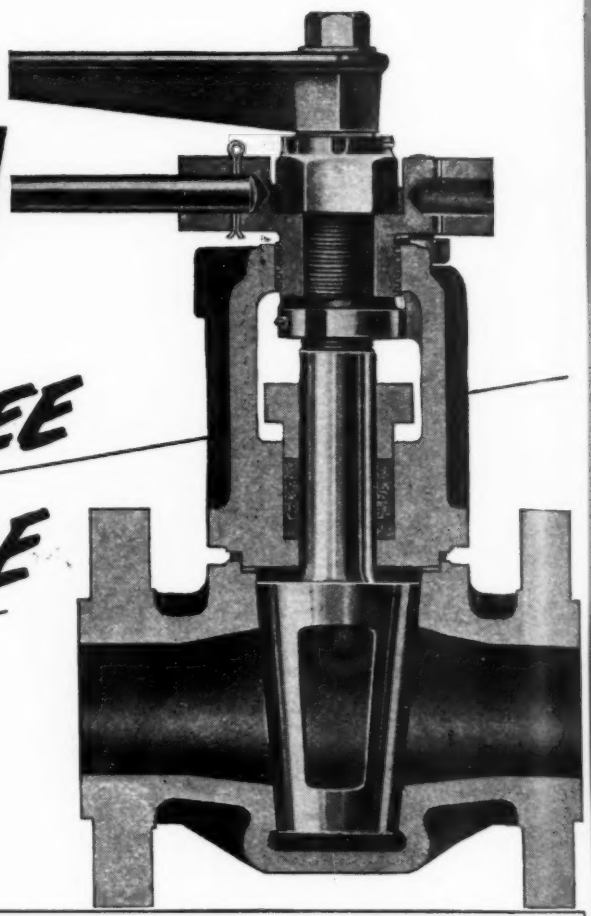
TRADE MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

6 Reasons Why

Homestead Lever-Seald Valves give

TROUBLE-FREE PERFORMANCE

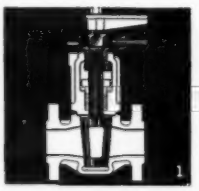


Hundreds of industrial plants are meeting today's demands for economy of operation and long, unfailing performance, by replacing old, defective valves with TROUBLE-FREE Homestead Lever-Seald Valves, and specifying them for new installations.

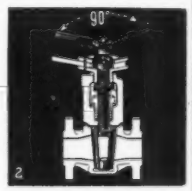
Homestead Lever-Seald Valves are *stick-proof.* They always work! Neither corrosive or viscous fluids nor extremes of temperature or pressure can make them stick. They operate 16 to 28 times faster than screw-stem-type valves because they are fully opened or closed by a *quarter turn.* They *seal without lubricants,* and their *seating surfaces are protected from corrosion or cutting action of fluids,* both when the valve is opened or closed. Their operating parts are fully protected, too, assuring longer service and lower upkeep.

There is a Homestead Lever-Seald Valve in the right metal or alloy to suit your requirements. Write for Valve Reference Book No. 38 for Homestead Lever-Seald Valves in sizes 1½" to 10", for pressure ranges from 150 to 1500 pounds. Consult Homestead engineers on all your valve problems.

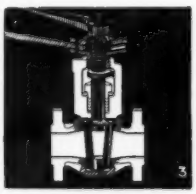
Shaded Valve Parts Show These Advantages:



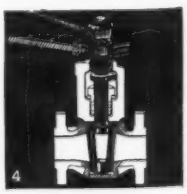
1. Instant, stick-proof operation assured by powerful leverage



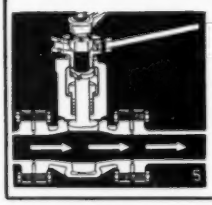
2. Quarter-turn fully opens or closes



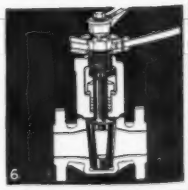
3. Positive seal without lubrication



4. Seating surfaces always protected in both open and closed positions. Corrosion practically eliminated



5. Unobstructed straight-line fluid flow —minimum pressure drop



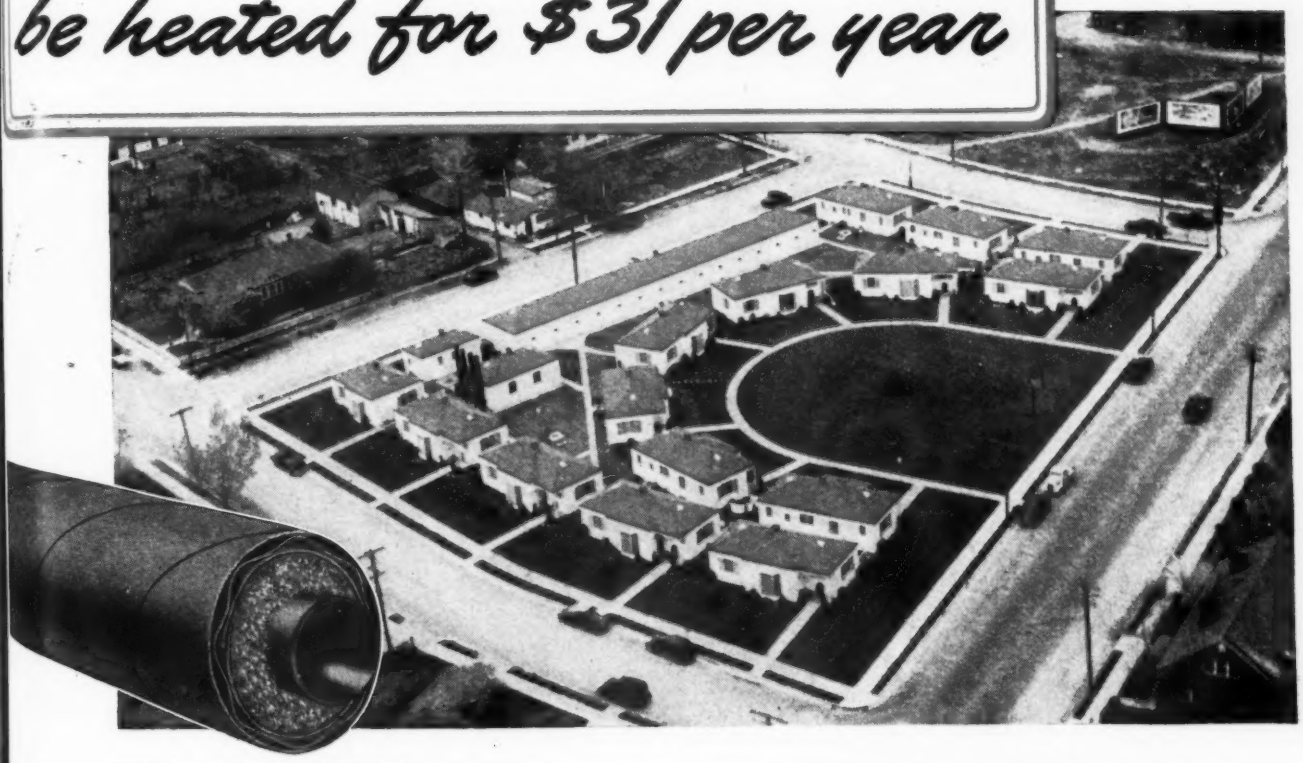
6. All operating parts protected from damaging effects of service conditions and weather.

"M" Pennant with two additional gold stars— Maritime's highest production award to our men and women making valves for the Victory Fleet.

Homestead LEVER-SEALD VALVES

HOMESTEAD VALVE MFG. CO. . . . P. O. BOX 210 . . . CORAOPOLIS, PA.

How the Post-war Home can be heated for $31 per year



EL RENO PROVES CENTRAL HEATING PRACTICAL FOR SMALL HOME COMMUNITIES

This is the story of a housing project completed in 1937, by a man whose thinking was years ahead of his time. On a 1½ acre tract in Reno, Nevada, he erected 18 buildings—15 separate dwellings, a garage, caretaker's cottage, and a central heating plant. Every detail in the project was carefully planned to provide maximum comfort and convenience to tenants—who are well satisfied to pay fair rent for each furnished unit consisting of living room, dining alcove, kitchen, two bedrooms, a bathroom and lavatory.

One of the outstanding features of the project is the central heating system—which provides hot water heat to the homes through Ric-wiL insulated under-ground conduit. Boilers use fuel oil. So efficient is this system that the heating bill for the entire project averages only $500.00 per year. Hot water for family use is also piped through Ric-wiL conduit from the central heating plant. These economies help the owner, Mr. Roland Giroux, to realize 13% net return on his investment.

EL RENO *Owner cites efficiency of Ric-wil Conduit*

"Regarding the cost of heating these sixteen units, here are the figures:

"Cost per month per apartment (5 rooms) for the 1937–1938 heating season:

"Total of 8019 gallons fuel at 6¼ cts. per gal.

Sept.	$ .81	Dec.	$5.12	Mar.	$4.94
Oct.	2.25	Jan.	5.50	Apr.	2.44
Nov.	3.75	Feb.	5.00	May	1.12

"Thus you will see that the heating costs are less than $4.50 per month, per suite. One cannot appreciate these heating costs unless they have been in the apartment business, where tenants will open their windows rather than lower the room thermostat, when too warm.

"There is no question in my mind that a central heating plant is more economical than separate units.

"The high efficiency of the Ric-wiL conduit is positive, from the above figures. The average 5 room house in Reno will use one ton of coal per month, at a cost of thirteen dollars per ton, during the heating season."

AS OF FEB. 28, 1944, MR. GIROUX HAS THIS TO SAY:

"This data is as true today as when the buildings were built. About the only thing I could add is that the amount of fuel oil used has not varied 100 gal. per year since the system was installed seven years ago, which proves to me that the efficiency of the insulated conduit does not lower as time goes on. The upkeep has been zero."

RIC-WIL INSULATED PIPE CONDUIT SYSTEMS
THE RIC-WIL COMPANY · CLEVELAND, OHIO
AGENTS IN PRINCIPAL CITIES

Power is one of America's most vital war weapons, for by it are all other weapons produced. Getting that power from its primary source to the driven machinery with minimum loss is a job many plants have given to Wood's Planned Power Transmission Equipment. Evidence aplenty indicates that it is performing the task well, without unnecessary time-losing shut-downs and with minimum maintenance.

Wood's Products have a heritage of 87 years service to American Industry, through several wars and eras of peace. Into this complete line of transmission equipment has gone much engineering knowledge and manufacturing skill to assure efficient, trouble-free operation.

Install Wood's Equipment to get maximum output today and long service through the years to come. Want more details? We'll gladly send them or ask one of the conveniently located Wood's Distributors.

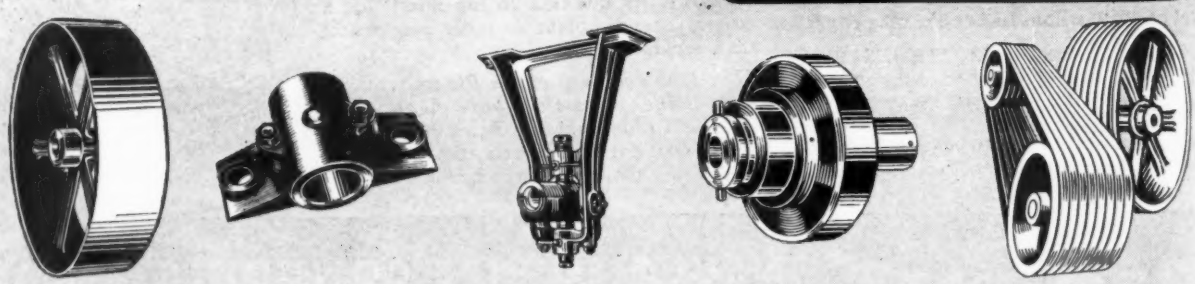
EVERYTHING IN TRANSMISSION

Bearings — Collars — Clutches — Couplings — Contactors — Hangers — Pillow Blocks — Pulleys — V-Belt Sheaves and Complete Drives

Wood's

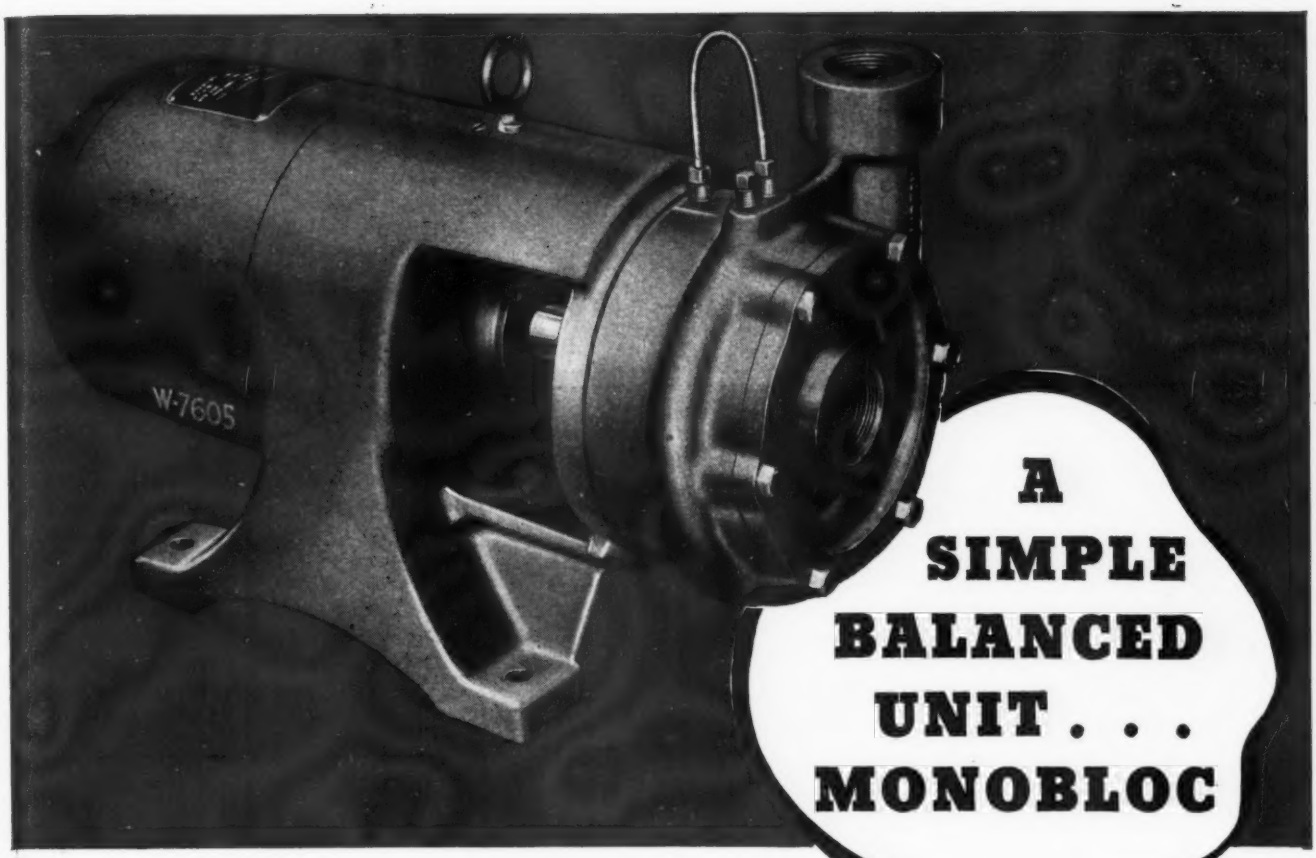
PLANNED POWER TRANSMISSION

the LONG LIFE LINE



T. B. WOOD'S SONS COMPANY, CHAMBERSBURG, PENNA.

BRANCHES: 387-391 ATLANTIC AVE., BOSTON, MASS. • 83 PLANE ST., NEWARK, N. J. • 425 FIRST AVE., PITTSBURGH, PA.



A SIMPLE BALANCED UNIT . . . MONOBLOC

. . . NOT just a pump and conventional motor

AN HYDRAULICALLY-BALANCED Worthington centrifugal pump plus a moisture-resisting, drip-proof motor designed exactly for the pump's precise job — that's the Worthington MONOBLOC.

That's what you see at a glance. Further inspection reveals that the pump's impeller is hand-finished, perfectly balanced and rigidly keyed to a large-diameter, short-length shaft. Another look shows plenty of room for gland inspection and adjustment. Then you notice the extra-high motor support as a precaution against floor flooding . . . and no need for a base plate. And when you finally observe the extra-large shielded grease retaining bearings for lengthening the unit's life . . . you must admit that every effort has been made to give you the most work for the least power expenditure.

For water supply, boiler feed, circulation, process waste, etc. — save space, power, time and money with MONOBLOC. Write today for Bulletin W–321–B14. And if you ever need the benefit of experience won from 15 years of MONOBLOC manufacture, contact an authorized Worthington dealer or our District office nearest you.

WORTH BEHIND THE NAME
WORTHINGTON

CPI-4

MONOBLOC

a complete line from ¼ to 60 H.P.

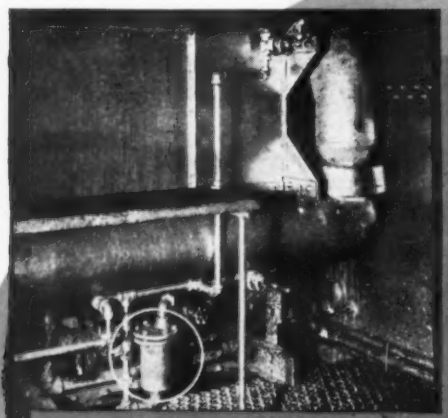
Part of Worthington's Standard Industrial Equipment Line For Re-Sale — including

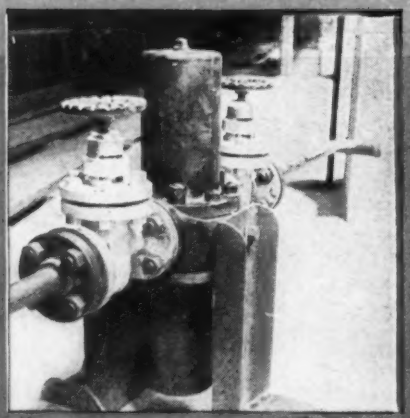
Centrifugal Pumps
Steam Pumps
Rotary Pumps
Power Pumps
Vertical and Horizontal Compressors
Industrial Meters
Multi-V-Drives with Q. D. Sheaves
Worthington Allspeed Drives

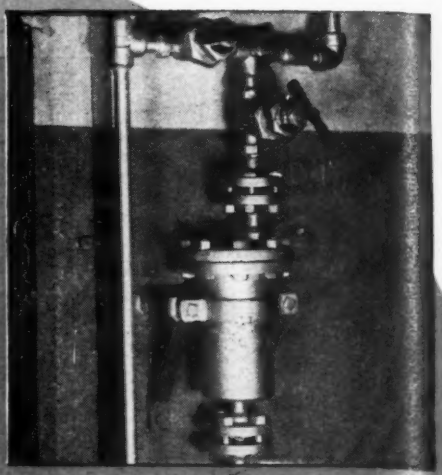
A 30 SECOND REVIEW OF MONOBLOC FEATURES

1. Balanced for extra strength and rigidity.
2. Impeller is hand-finished and keyed to shaft.
3. Motor is moisture-resistant and drip-proof.
4. Motor support elevated to avoid floor-flooding.
5. Ample room for gland inspection and adjustment.
6. One-piece shaft has large diameter . . . keeps moving parts true.
7. Shielded bearings are extra large for extra life.

Standard Products Division
WORTHINGTON PUMP AND MACHINERY CORPORATION, HARRISON, N. J.







● The photographs show an exterior view of one of the many Armstrong-equipped central stations . . . applications of Armstrong high pressure traps in power plant and marine service . . . and an Armstrong compound trap draining steam header in a municipal plant.

The diagram: trap hookup providing protection for pressure reducing valve and desuperheater on high pressure steam line.

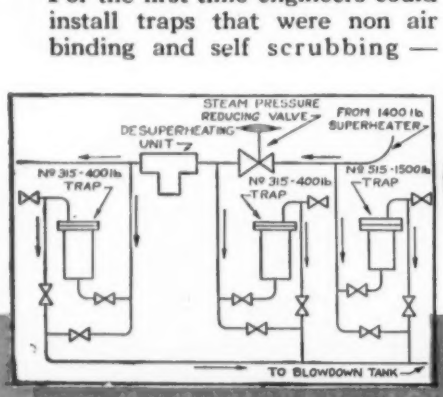
Armstrong *Inverted Bucket* TRAPS Standard for High Pressure Service

Way back in 1911 a boiler pressure of 125 lbs. was considered really "high pressure". And steam traps had developed no farther than these "high pressure" boilers. In that same year Armstrong built the first inverted bucket trap that sounded the death knell to such practically obsolete contraptions as pet cocks to prevent air binding and drain connections to get rid of sediment and sludge. For the first time engineers could install traps that were non air binding and self scrubbing — could install traps and forget them.

The rise in boiler pressures which began after World War I was paralleled by material and design improvements in the Armstrong Trap. To name a few: heat treated chrome steel valve parts replaced brass and bronze, steel forgings replaced castings, stainless steel buckets replaced brass. A frictionless leverage system replaced the original leverage design which took power to operate and time and money to maintain.

Because of these and other improvements, the Armstrong Traps are as modern as the high pressure boilers with which they are used. This is why so many high pressure Armstrong traps are in service and why the words Armstrong and steam trap are synonymous to power plant engineers.

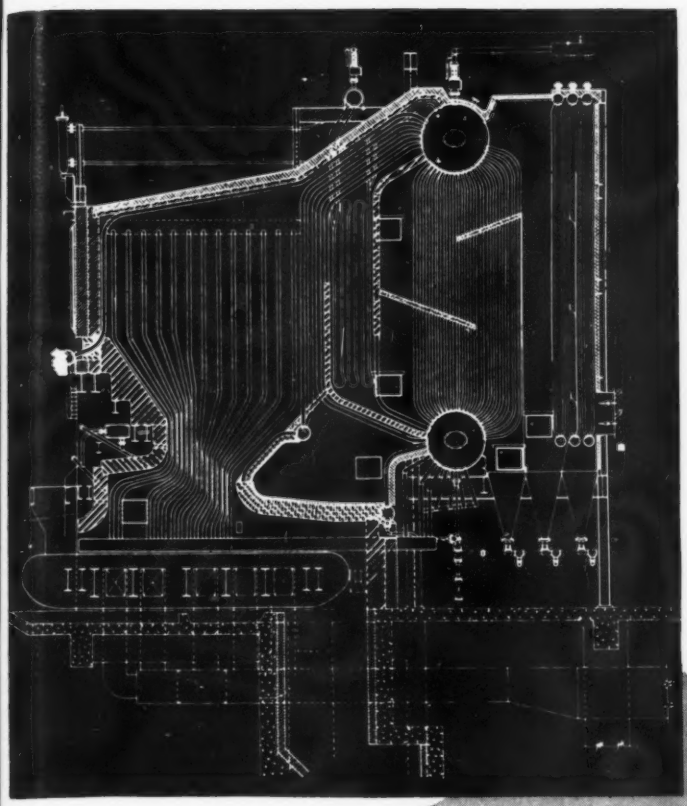
The Armstrong Steam Trap Book goes into detail as to design and contains complete data for sizing and installing high pressure traps. A copy is yours for the asking. Just write Armstrong Machine Works, 812 Maple Street, Three Rivers, Michigan.


STEAM PRESSURE REDUCING VALVE
FROM 1400 lb SUPERHEATER
DESUPERHEATING UNIT
№ 315 - 400 lb TRAP
№ 315 - 400 lb TRAP
№ 515 - 1500 lb TRAP
TO BLOWDOWN TANK

ARMSTRONG STEAM TRAP

Armstrong

STEAM TRAPS • HUMIDIFIERS • PURGERS



Edge Moor 2 DRUM DESIGN serves Overseas!

Here is a steam generating unit well suited to wartime requirements. This Edge Moor 2-drum boiler produces 68,000 pounds of steam per hour at 450 pounds pressure and at 760° F. final steam temperature. The design takes full advantage of water-cooled walls and economizer equipment. Built-in features of rapid steaming, high overload capacity, accessibility and easy maintenance are included in this plant. A battery of these Edge Moor 2-drum boilers serves a fighting ally overseas.

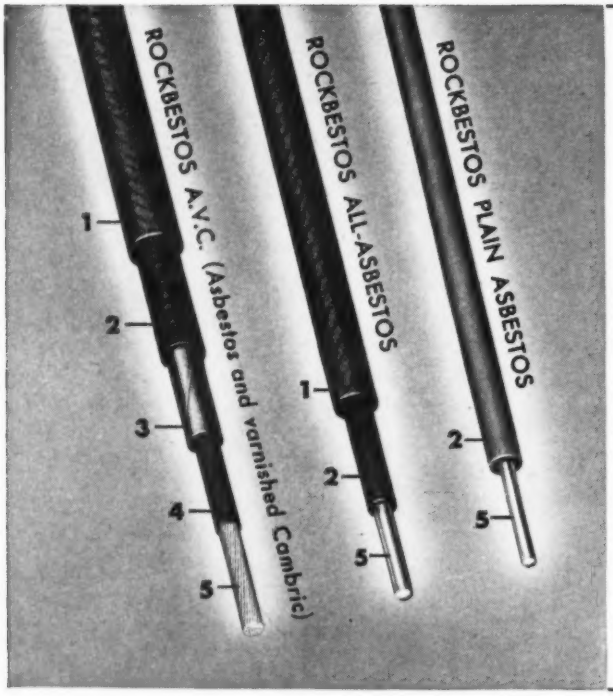
These boilers are a typical example of Edge Moor's contribution to the war effort and can be duplicated promptly from designs already developed and approved. Write for additional information or send us your requirements.

STEAM GENERATING EQUIPMENT

BRANCH OFFICES: NEW YORK CITY: 30 ROCKEFELLER PLAZA
CHICAGO, ILL.: 1 NORTH LA SALLE ST.

EDGE MOOR IRON WORKS, INC.

MAIN OFFICE: EDGE MOOR, DELAWARE



3 GETS YOU 122

122 wires, cables and cords, stemming from the three basic designs illustrated, have been developed by Rockbestos to give trouble-free performance under severe operating conditions in steel mills, power plants, chemical industries, etc. Send for catalog to see the rest.

Rockbestos Permanent Insulation Insures Long-Lived Performance

1. A tough, rugged asbestos braid, resistant to heat, flame, moisture, oil, grease and corrosive fumes.
2. Felted asbestos insulation impregnated with heat-, flame-, and moisture-resisting compounds will not dry out, become hard and brittle, or burn. Also serves as a heat-barrier against high ambient temperatures.
3. Lubricated varnished cambric for high-dielectric strength and added moisture resistance, protected from heat, flame, and oxidation by felted asbestos walls.
4. Felted asbestos insulation that withstands conductor-heating overloads and won't burn even when exposed to copper-melting arcs.
5. The conductor is perfectly centered in helically applied insulation and will always remain so.

600 VOLT A.V.C. SWITCHBOARD WIRE—TABLE B
(Underwriters' Type AVB)

Sizes No. 18 to 4/0 A. W. G. with varnished cambric and felted asbestos insulation and gray, black, white or colored flameproof cotton braid.

Combine fire insurance and fine appearance in your switchboards with Rockbestos Switchboard Wire. It is absolutely fireproof and will not dry out under heat. Sharp, clean bends can be made without cracking as the asbestos wall acts as a cushion under the braid. Rockbestos A. V. C. Hinge Cable and Switchboard Bus Cable have the same fireproof and heatproof characteristics.

INDUSTRIAL HEATING CABLE—TABLE LH

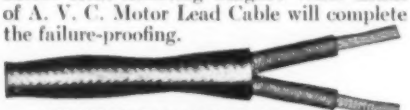
No. 19 A. W. G. nickel-chromium wire insulated with .040" of felted asbestos and covered with 1/64" waterproof lead sheath.

This pliable cable distributes a mild heat evenly over a large area. Prevents freezing of water pipes, wet pipe sprinkler systems, etc. Keeps conveyor pipes for fuel oil, soap, varnish, ink, chocolate, etc., at temperatures that insure steady flow.

ASBESTOS INSULATED MAGNET WIRE

Round, square and rectangular asbestos insulated conductors finished to meet varying winding conditions and coil treatment requirements.

Protect your motors against heat-induced breakdowns with class B windings of Rockbestos Heat-Resisting Magnet Wire. Leads of A. V. C. Motor Lead Cable will complete the failure-proofing.



ALL-ASBESTOS FLEXIBLE CORD—TABLE CA

Sizes No. 10 to 18 A. W. G. with two or three conductors insulated with felted asbestos, covered with asbestos braid. Also in A. V. C. (asbestos and varnished cambric) constructions.

This heat-resisting flexible cord is ideal for high-wattage lighting units, floodlights, blueprint machines, apparatus, etc., which require a heavy duty, enduring cord. For moisture-resistant construction specify the A. V. C. type. Labeled cord with polarized conductors if desired.

600 VOLT A.V.C. BOILER ROOM WIRE—TABLE C
(Underwriters' Type AVA)

Sizes No. 18 to 4/0 A. W. G. This construction for sizes 18 to 8, sizes 6 to 4/0 have another wall of felted asbestos next to the conductor.

For lighting and control circuits exposed to heat and moisture, oil, grease, corrosive fumes or fire hazard, such as exist around furnaces, ovens, lehrs, soaking pits, boilers, etc., this widely used A. V. C. construction is ideal. Also for locomotive panel wiring and for switchboards requiring an asbestos braided wire.

THERMOSTAT CONTROL WIRE—TABLE TC

Sizes No. 14, 16 and 18 A. W. G. in two to six conductors with 12½, 25 or 31 mil wall of felted asbestos insulation and cadmium plated steel armor.

A multi-conductor control wire for low voltage intercommunicating, signal and temperature control systems. Its lifetime insulation and rugged steel armor will give you trouble-proof circuits.

600 VOLT ALL-ASBESTOS RHEOSTAT CABLE—TABLE R
(Underwriters' Type AI)

Size No. 18 A. W. G. to 1,000,000 CM insulated with a heavy wall of felted asbestos, covered with a rugged asbestos braid finished in black, white or colors.

Use this power and rheostat cable for wiring rheostats, switchboards, elevator and locomotive control panels and electrical equipment exposed to heat, fumes and fire hazard. Also for general open wiring in dry, high temperature locations. For solid conductor specify Rockbestos Rheostat Wire, Table A.

600 VOLT A.V.C. MOTOR LEAD CABLE—TABLE L
(Underwriters' Type AVA)

Sizes No. 18 A. W. G. to 1,000,000 CM insulated with two walls of felted asbestos and a high-dielectric, heat-sealed varnished cambric insert, covered with heavy asbestos braid.

Heatproof, fireproof, greaseproof and oilproof, will not dry out and crack, won't burn or carry flame, and remains permanently flexible. For coil connections, motor and transformer leads where extreme heat and fire hazards are encountered as in steel mills, etc.

600 VOLT A.V.C. CONTROL CABLE

In one to 19 conductors. Standard stranding A. W. G. No. 12—19/No. 25 and No. 9—19/No. 22. Other strandings furnished.

Designed for use under conditions too severe for control cables with other types of insulation which deteriorate rapidly when exposed to high temperatures. Operates without failure under the attack of heat, oil, grease or corrosive fumes and may be installed in conduit as it has ample moisture resistance.

600 VOLT A.V.C. POWER CABLE—TABLE E
(Underwriters' Type AVA)

Sizes No. 18 A. W. G. to 1,000,000 CM insulated with laminated felted asbestos, varnished cambric, and asbestos braid. Other constructions for service voltages to 8000.

Recommended for power circuits and hot spot wiring in or around boiler rooms, steam tunnels, soaking pits, tenter frames, glass plants, etc. The asbestos and heat-sealed varnished cambric construction has ample moisture resistance and withstands high temperatures.

Rockbestos Products Corporation, 939 Nicoll Street, New Haven, Conn.

WON'T bake brittle, bloom, burn or rot—RESISTS heat, moisture, oil, grease and fumes

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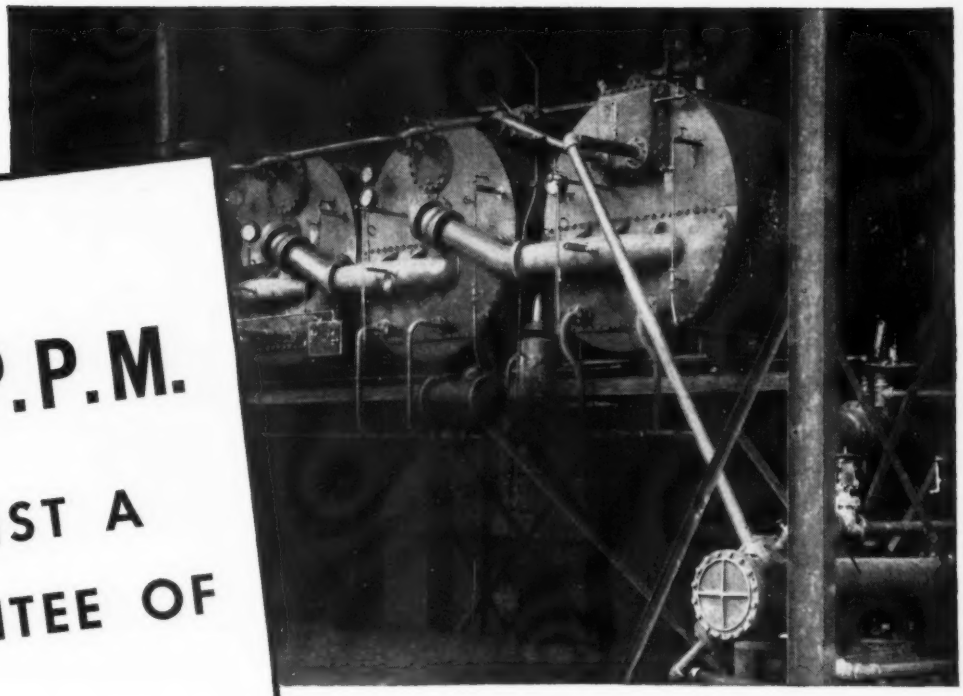
The Wire with Permanent Insulation



1.72 P.P.M.

AGAINST A GUARANTEE OF

4.3 P. P. M.

Prior to its installation, this Lummus Triple Effect Evaporator was submitted to severe factory tests. In these tests and in subsequent service the efficiency of the Lummus design was verified by the purity of the product: 1.72 P.P.M. against a specification of 4.3 P.P.M.

Lummus makes a complete line of single and multiple effect evaporators for power plant, process and marine service. These Lummus Evaporators are characterized by high efficiency, low steam consumption per pound of water produced, compact design, low scaling and other features.

The services of Lummus personnel are available for the study of power plant and process applications of evaporative and other heat exchange equipment.

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- ★ Bleeder Heaters
- ★ Boiler Blowdown Heat Exchangers
- ★ Evaporators
- ★ Fuel Oil Heaters
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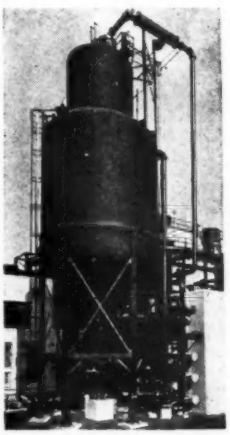

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In a short time after actual shut-down, with our special hydro-dynamic shock test, we can tell you how many bad tubes you have. If the number is small, and plugging will get you by for a reasonable length of time, we'll give you the good news and have you back in service *pronto.*

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For fifteen years, now, we have been servicing condensers and heat exchangers for utilities and industrial power plants throughout the nation. During this time we have developed our own time-saving tools and methods to give you a better, faster job. Today we are operating on a clock-around schedule — *Emergency Service* is our normal business. Don't hesitate to call us any hour of the day or night.

Condenser Service
AND ENGINEERING CO., INC.

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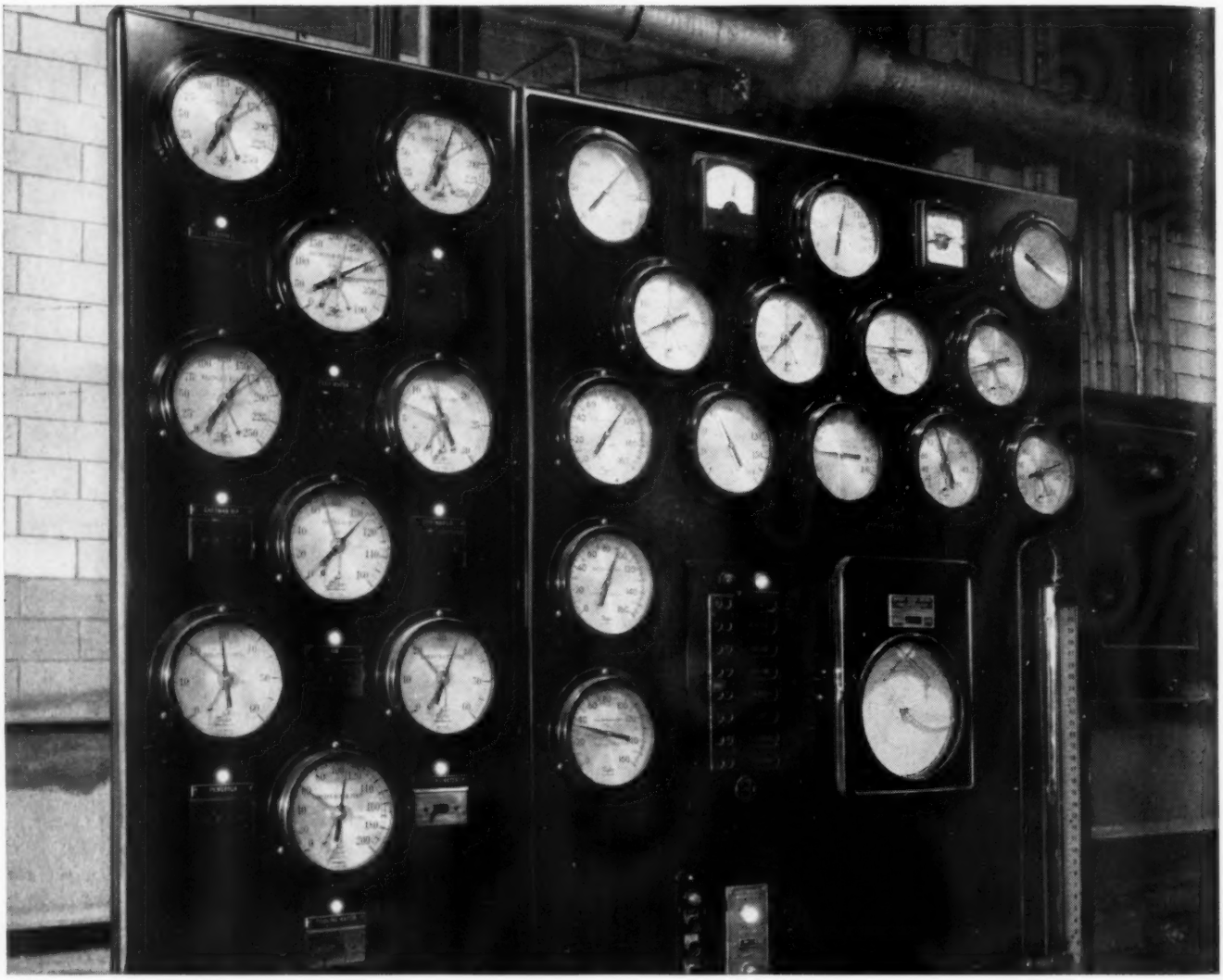
NEW JERSEY TELEPHONE—HOBOKEN 3-4425

NEW YORK TELEPHONE—RECTOR 2-9360 **AFTER 6 P. M. AND SUNDAYS—HOBOKEN 3-4428**

4-CS-1

Eyes that cry when you're in trouble



THESE "eyes" are standing by ready to "cry" when trouble strikes in any part of the power plant. They're Taylor Dial Thermometers, equipped with electric alarm devices that tell you of approaching danger through an increasing or decreasing temperature. Their warning cry can take the form of lights, bells, horns, whatever you prefer.

Many power plants are now using these alarm thermometers on transformers, coal-air mixture in powdered coal ducts, air compressor discharge, turbine and generator bearings. You can depend on their accuracy—because Taylor has meant "Accuracy First" since 1851. Ask your Taylor Field Engineer for full details. Taylor Instrument Companies, Rochester, N. Y. and Toronto, Canada. *Instruments for indicating, recording, and controlling temperature, pressure, humidity, flow, and liquid level.*

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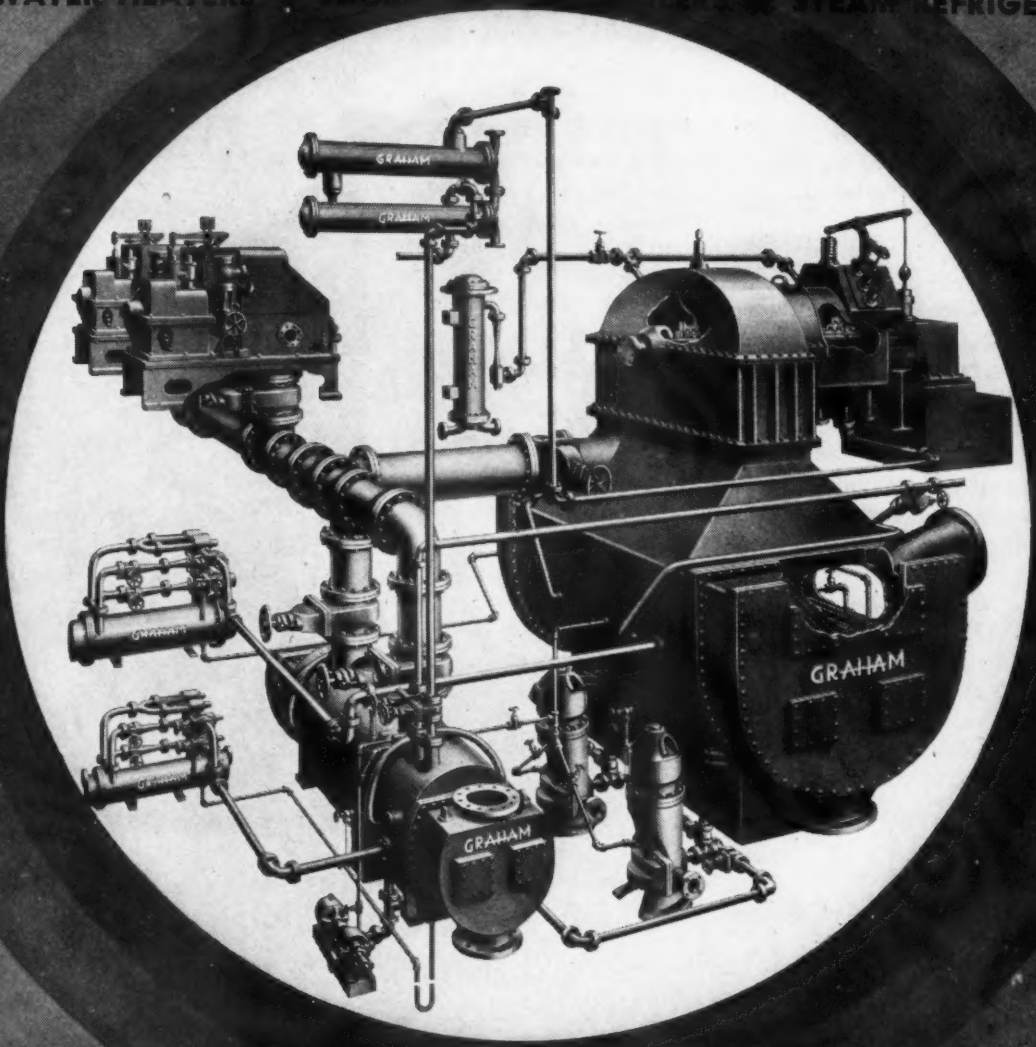
★ FEED WATER HEATERS ★ JACKET [illegible] ★ STEAM REFRIGERATION



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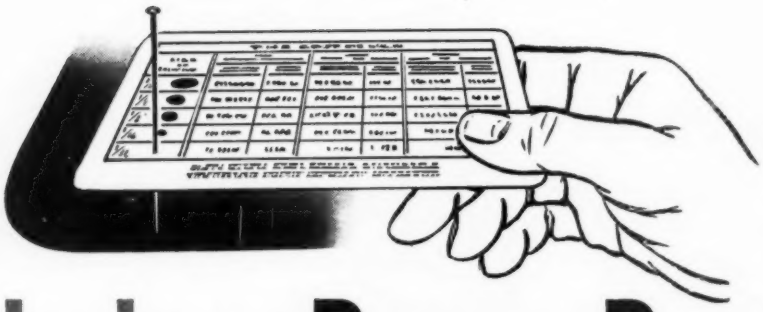

How Big is a pinhole in a POWER PLANT?

Big enough to cause a lot of trouble—when the pinhole is in the seating of a valve that's supposed to be shut off *tight*.

Here's the story in terms of normal pressures:

At 100 lbs. — STEAM — 3,175 lbs. wasted per month per valve

At 100 lbs. — AIR — 69,552 cu. ft. wasted per month per valve

At 40 lbs. — WATER — 4,800 gals. wasted per month per valve

This is just a $\frac{1}{32}$" hole, at normal pressures. A pinhole across the seat of a 1" valve is a leak that might have called for a new valve before the war. In a 16" valve, on the other hand, it may be regarded as "normal seepage."

The point is, you can *reseat* ANY globe valve from $\frac{1}{4}$" to 14"; or ANY gate valve from $1\frac{1}{2}$" to 48"; *without removing it from the line,* and you'll come out with a valve that doesn't leak at all! . . . not even "normal seepage!" All you do is remove the bonnet and insert a Dexter Valve Reseating Machine. In a few minutes you have cut a new face on the ports: a face that is true — in fact, better than usually found in a new valve.

There are Dexter outfits specially designed for reseating reciprocating pump valves from 2" to 15".

In most cases a valve can be reseated on the line in less time than would be required for removal and replacement.

Have you any leaky valves? Write us about them — we'll recommend the Dexter Valve Reseating Equipment that will handle your situation economically.

THE LEAVITT MACHINE COMPANY
ORANGE, MASSACHUSETTS

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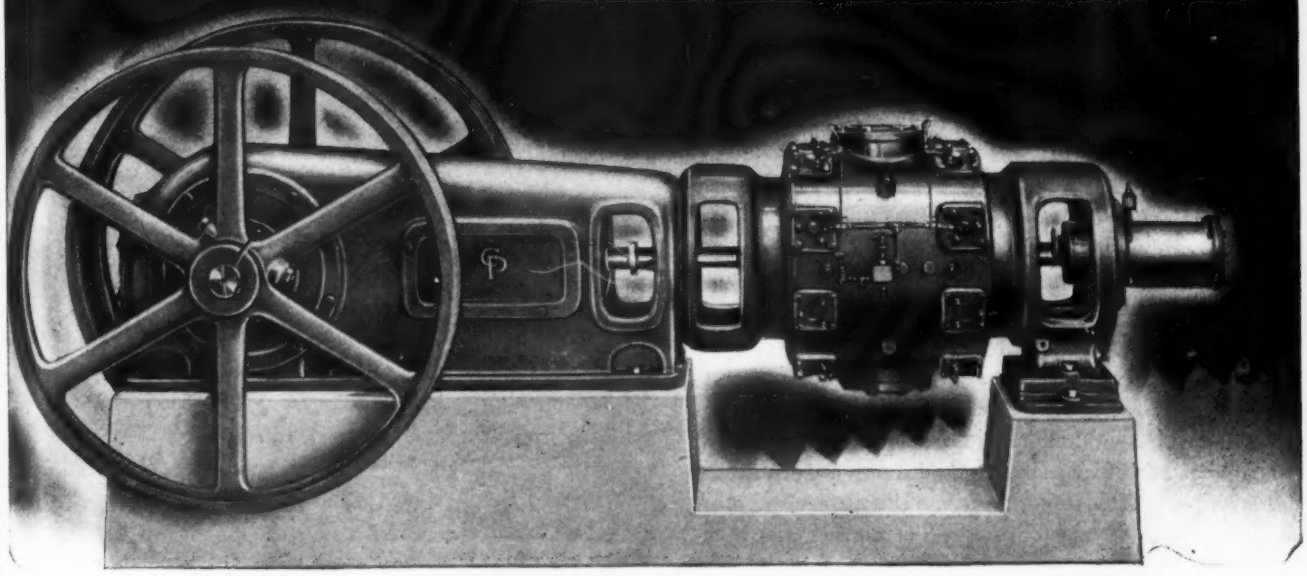
CP Oil-less Cylinder Compressors are arranged for belt, motor or steam drive, in single stage and two-stage types. They are available for early delivery in a wide range of sizes and ratings. Write for literature.



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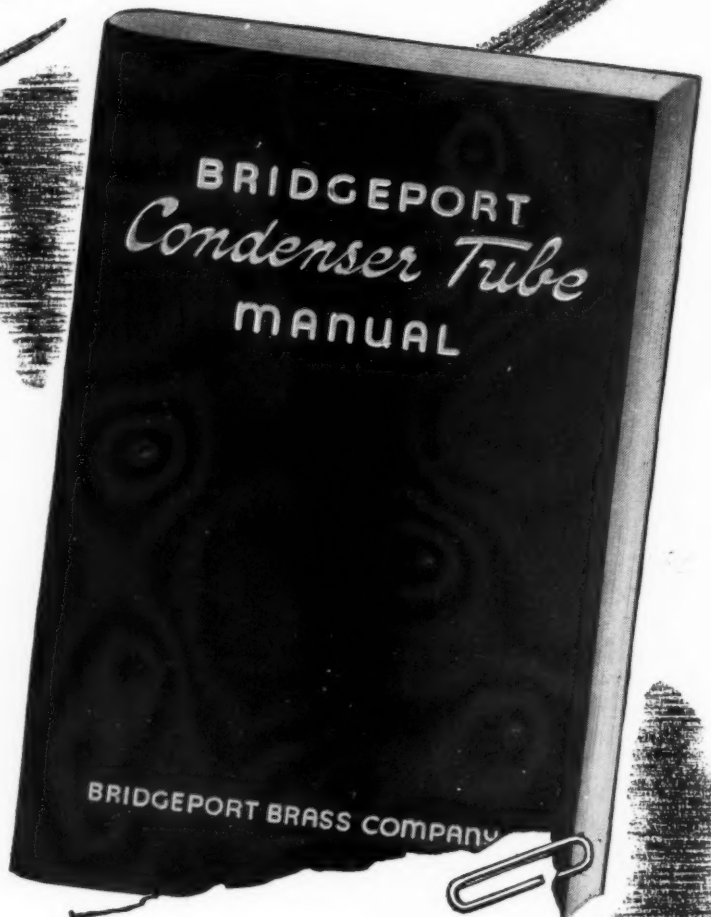
This New Technical Booklet
SHOULD BE IN THE HANDS OF
Every Engineer and Technician
CONCERNED WITH THE
Selection and Maintenance of Tubing



Much new and heretofore unpublished information on copper-base alloys that should be of great help to everyone concerned with the selection and maintenance of tubing for installations in condensers, heat exchangers, evaporators and for general piping.

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The manual contains the latest A. S. T. M. and Federal Specifications on standard alloys, comprehensive weight tables, steam notes, methods of installing and packing, cutting and removing condenser tubes. It also contains weight tables and data on brass and copper pipe, copper water tubing and navy type copper tubing.

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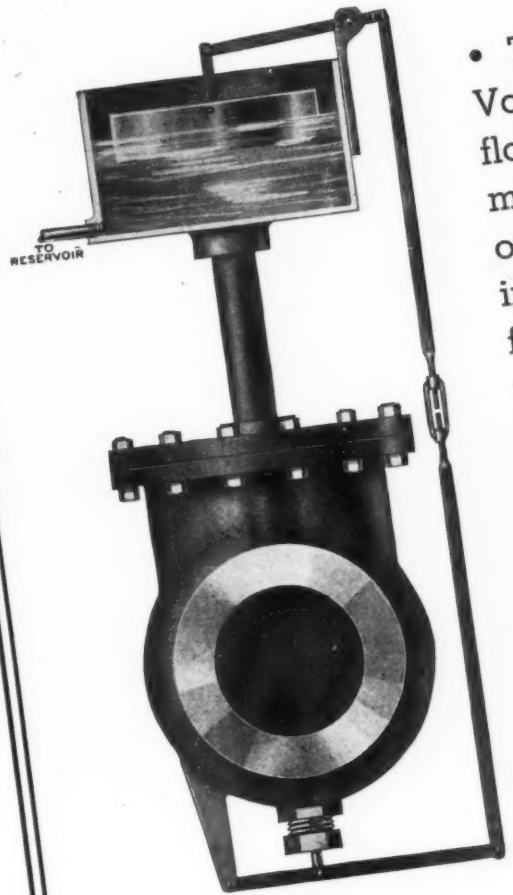
...For Water Level Control in Mixing Chambers, Coagulating Basins, Reservoirs, etc.



• The G-A Float Control Valve is designed to control flow-rate in proportion to demands and is available for operation under low or high inlet heads, for keeping a uniform water level. Double water cushioning insures smooth, sensitive operation. Valve is designed with V-shaped ports or saw-tooth liner-seat for reliable operation under minimum or maximum service requirements. In closed position the valve seats absolutely tight.

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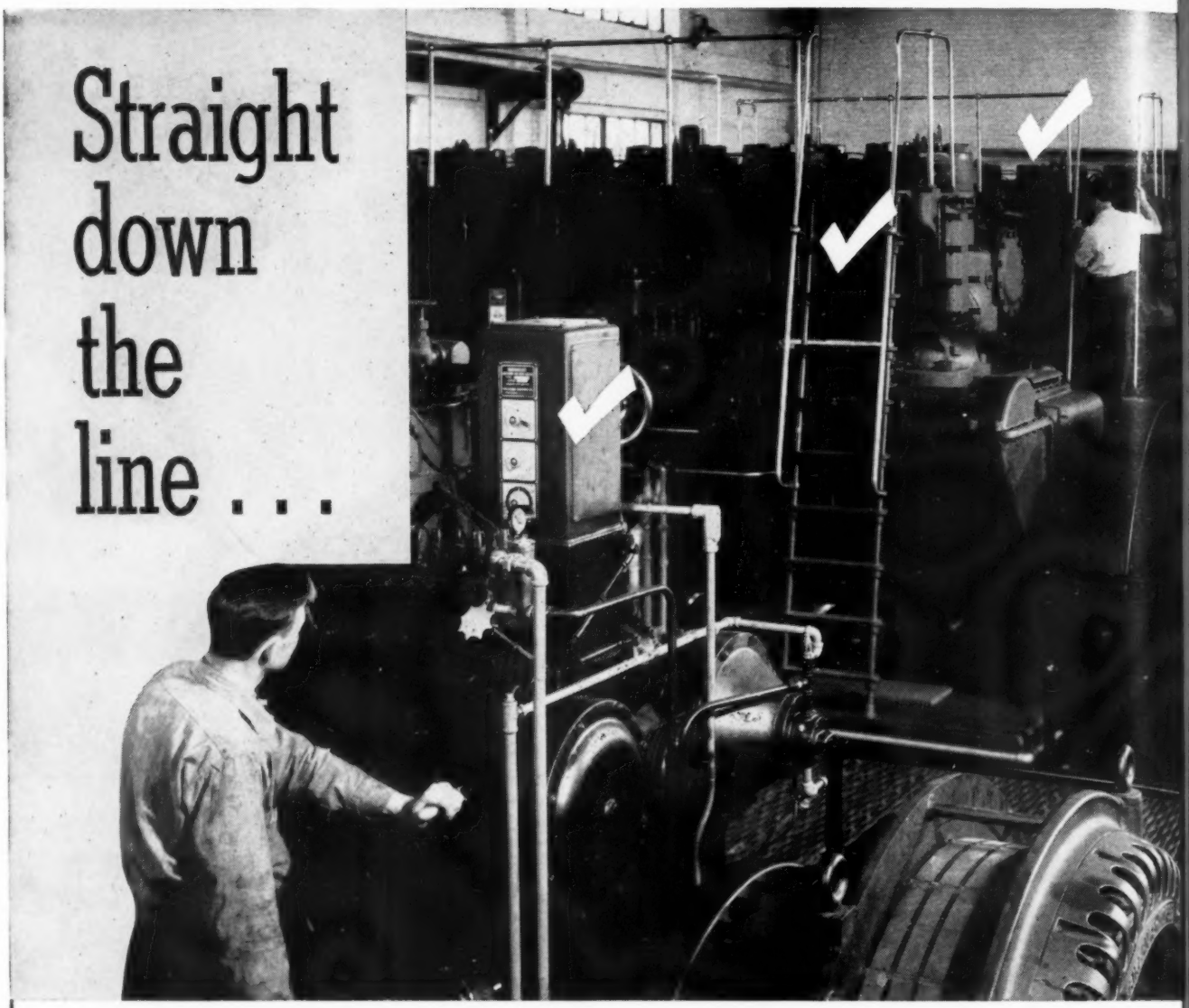

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FACTS FOR PUMP OPERATORS

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REFINERS OF PETROLEUM

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GENERAL OFFICES
CLEVELAND, O.

Coraopolis, Pa.
November 1, 1943

Darling Valve & Manufacturing Company
Williamsport, Pennsylvania

Gentlemen:

You might like to know the facts regarding the Darcova Pumcups which we installed here last spring.

Previously we had been using hydraulic packing on Cameron boiler feed pumps, 10 X 7 X 13, pumping 180 gallon of water at 125oy., using 125# steam. The piston travel was 103' per minute.

Over a period of fourteen years we had changed packing about every two weeks.

On March 29, 1943, we installed your Darcova Pumcups with Darling pistons. These cups are still in service and are now beginning their eighth month.

We have not only gotten our money's worth out of the cups but have saved money and time. We have now installed Darcova Pumcups on two other pumps, one pumping oil and one pumping water.

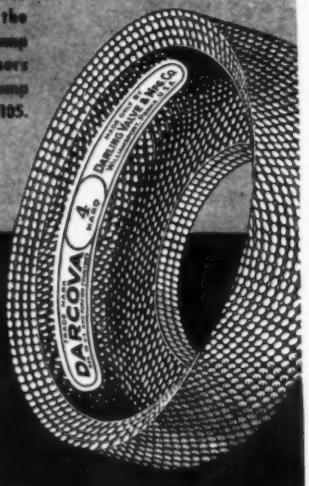
Very sincerely,

THE CANFIELD OIL COMPANY

By R. W. Helm
R. W. Helm,
Superintendent

RWH:MLB

Darcova Pumcups have been used by leading operators for more than thirty-five years. Darcova Pumcups can readily be applied to any reciprocating pump. ● By employing the simple cup principle, Darcova increases pump capacity and pumping efficiency. ● Users experience savings up to $100 per pump per year. Send for free bulletin No. 4105.



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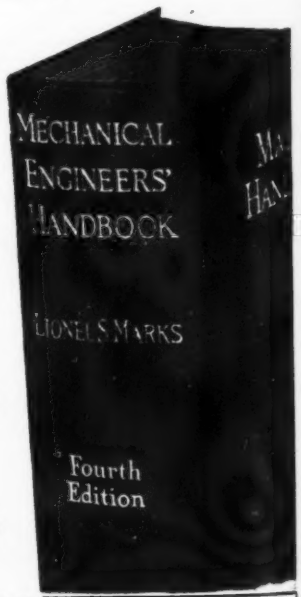

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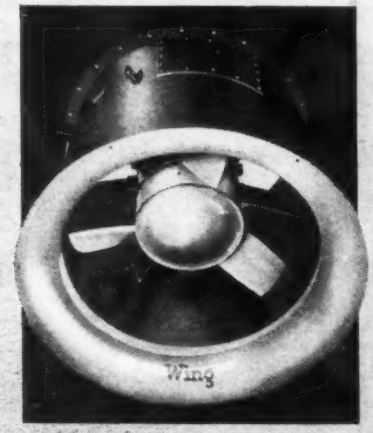

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ONE BIG ADVANTAGE of the LST type of invasion landing is the fact that the tanks, jeeps, and motorized artillery can "come out fighting". There is no long suicidal wait for equipment to be lowered over the side of the ship and ferried ashore, no agonizing uncertainty while motors are started and gears shifted. No—the motors of the death-dealing mechanized equipment are started before the landing ship reaches shore. Numbers of Wing Axial Flow Blowers (each with a capacity of 35,000 CFM at 1 inch static pressure) suck the deadly gases out as fast as they are discharged from the exhaust pipes, keeping the air clean and wholesome in spite of the roaring engines. Then the ship beaches, the doors open and out come the fighting machines and swing into action.

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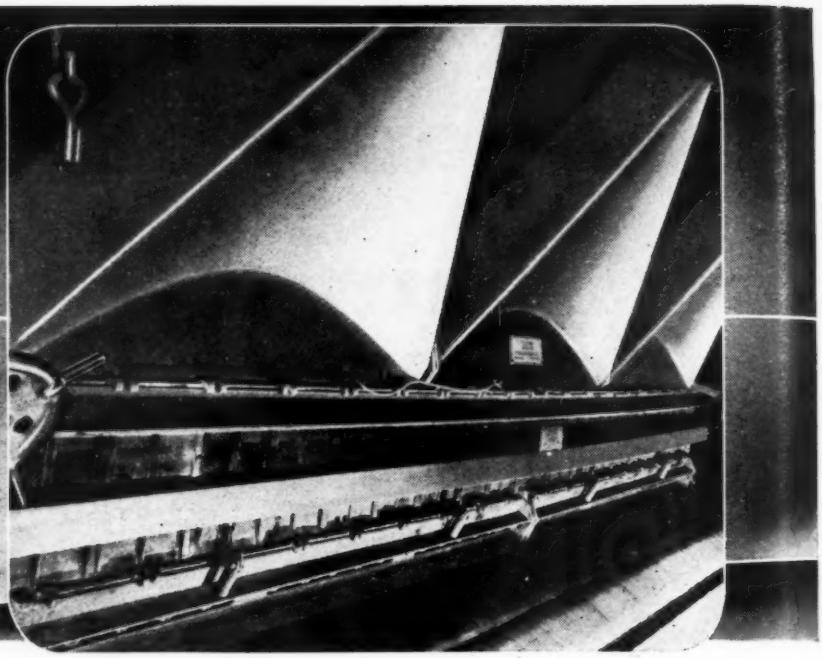
Can You Burn "Real Estate?"



● "Real Estate"—fine black or clay dirt bears resemblance to some war-time coals that have not been as thoroughly cleaned as either the producers or users would like. This material sticks in chutes, scales, and valves—hence operating troubles and still more operating troubles. Have you had these difficulties yourself this winter? If so, a properly designed "Bunker to Stoker" or "Bunker to Pulverizer" installation may prove to be a solution to part of your troubles. Why not check with the Stock Engineering Company, 9807 Theodore Ave., Cleveland, Ohio?

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CONICAL Non-Segregating Coal Distributors ★ ★ **S.E.Co. Coal Valves and Coal Scales**

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OPERATE EASY

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"TOLEDO" No. 101 and No. 102 Adjustable Bolt Die Stocks are furnished in popular sizes. No. 101 capacity ¼" to ⅝". No. 102 capacity ½" to 1". Full-mounted for instant use or one die stock and dies and guides in the sizes desired.

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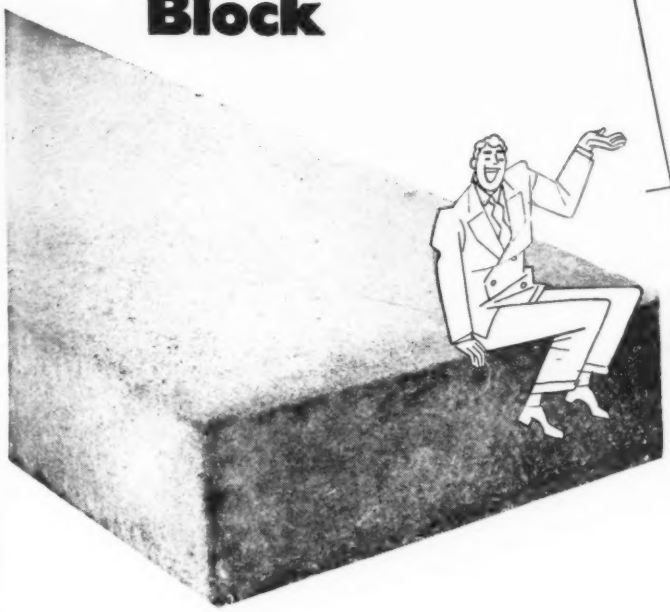
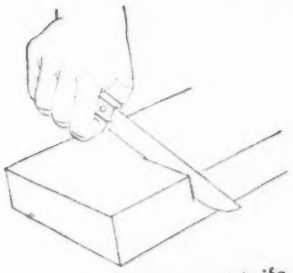
BACK THE ATTACK ***BUY WAR BONDS***

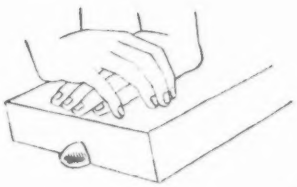
IMPORTANT FACTS ABOUT EAGLE-PICHER MINERAL WOOL INSULATIONS

EAGLE
Supertemp Block





Cuts easily with knife or saw to fit irregularly shaped areas.



Fits snugly over minor irregularities, such as rivet heads.

This all-purpose high temperature block withstands a full range of temperatures up to 1700° F. . . . has extremely low thermal conductivity. Honeycombed with thousands of "dead" air cells essential to high efficiency. Supertemp Block has ample compressive strength and is structurally strong enough to withstand normal handling and usage. Makes a neat workmanlike job. Ease of application means low cost per square foot.

Application is speeded and simplified by using Eagle Insul-stic for a temporary bond—a strong paste-like adhesive with high coverage.

A few recommended uses for Eagle Supertemp Block: breechings, tanks, ovens, boiler walls, hot air ducts, heat-treating furnaces.

These Mineral Wool Properties Make Supertemp Block Remarkably Efficient!

Chemical and Physical Stability

Eagle Mineral Wool is chemically neutral. Since it is neither basic nor acidic, it contains no element to cause rust and corrosion on metal equipment. The fine mineral wool fibers withstand prolonged vibration and enable Eagle Supertemp Block to give long service without "breaking down."

High Refractory Value

Eagle Mineral Wool is a distinctive high temperature insulation that does not oxidize or change its physical characteristics at the temperatures recommended. The great refractory value of Eagle Mineral Wool has made possible the development of such high temperature insulation as Eagle Supertemp Block.

FREE MANUAL! Shows how insulation on a single boiler shell can save as much as $1500 a year in fuel costs. Gives many other examples.

Write for a copy of this timely manual that shows how *you* can conserve industrial heat and power, and save hundreds of dollars a year in fuel costs, with mineral wool insulation. *Address Insulation Division, Eagle-Picher Lead Company, Cincinnati (1), Ohio.*

★ *Let's ALL back the attack—buy ANOTHER War Bond!* ★

EAGLE-PICHER HIGH TEMPERATURE INSULATIONS

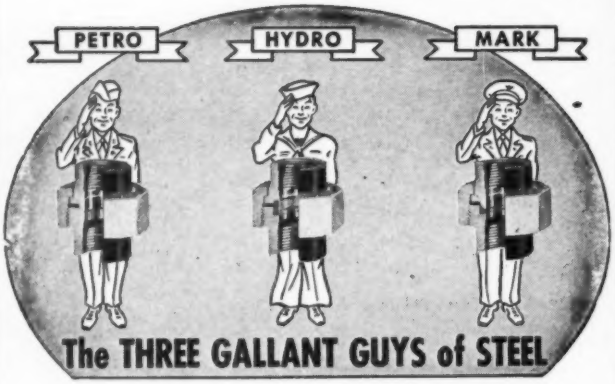
Eagle Super "66" Plastic Insulation
Eagle Supertemp Block
Eagle L-T and M-2 Felt
Eagle Blankets

EAGLE Ep PICHER

Eagle Finishing Cements
Eagle Loose Wool
Eagle Insulseal
Eagle Insul-stic

THE EAGLE-PICHER LEAD COMPANY, Cincinnati (1), Ohio

FORGED STEEL UNIONS



AT YOUR SERVICE with

THE "MARK A.A.R." UNION

AMERICA'S FIRST STEEL UNION

EXCLUSIVE FEATURES

THAT PAY DIVIDENDS TO THE USER

Extra heavy ends and nut. Permanently lubricated nut threads, bronze seats completely fused to the steel, then machined and cold rolled.

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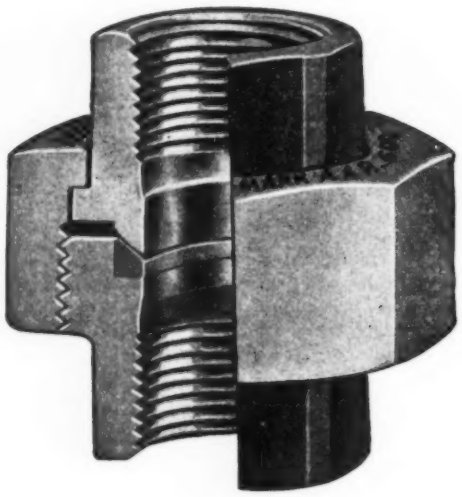
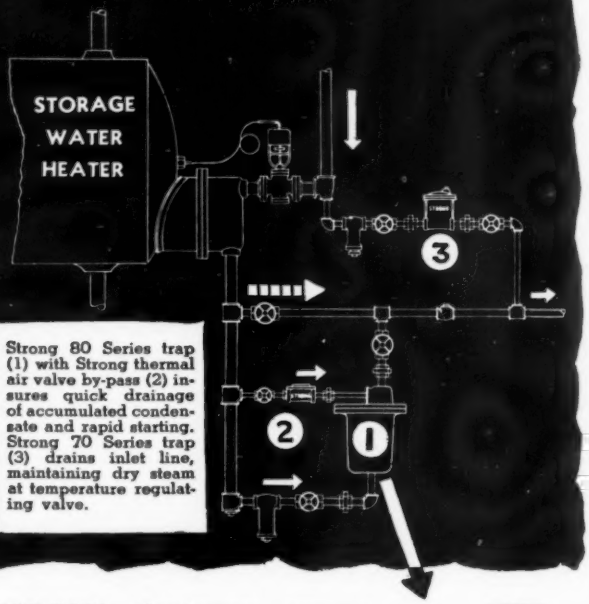


Clayton **MARK** *& Company*

ORIGINATORS AND PIONEERS OF STEEL UNIONS SINCE 1912

EVANSTON **ILLINOIS**

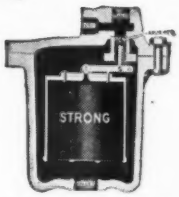
PREVENT DANGEROUS WATER HAMMER!



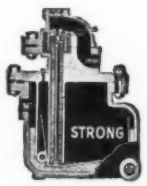
Strong 80 Series trap (1) with Strong thermal air valve by-pass (2) insures quick drainage of accumulated condensate and rapid starting. Strong 70 Series trap (3) drains inlet line, maintaining dry steam at temperature regulating valve.

PROBLEM: Condensate accumulates in coils due to lack of pressure when regulating valve is throttling or closed. Water hammer results when steam regulating valve opens.

SOLUTION: Drain coils *fast.* Use trap with 4 to 8 times capacity of actual steam condensate rate. For medium or high pressures, either open or inverted bucket traps are suitable. ***Use open bucket traps for low pressures.***



Strong 80 Series Trap for medium or high pressures



Strong 30 Series Trap for low pressures

• • •

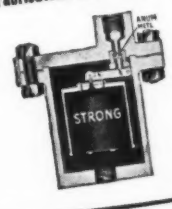
Completeness of the Strong trap line enables us to recommend exactly the type or size needed—open or inverted bucket, closed float, float-and-thermostatic (blast), etc.—forged, welded, cast or semi-steel construction. Send your drainage problems to Strong, Carlisle & Hammond Company, Cleveland, Ohio.

OTHER STRONG STEAM SPECIALTIES

Reducing Valves

Strainers

Fabricated Steel Traps

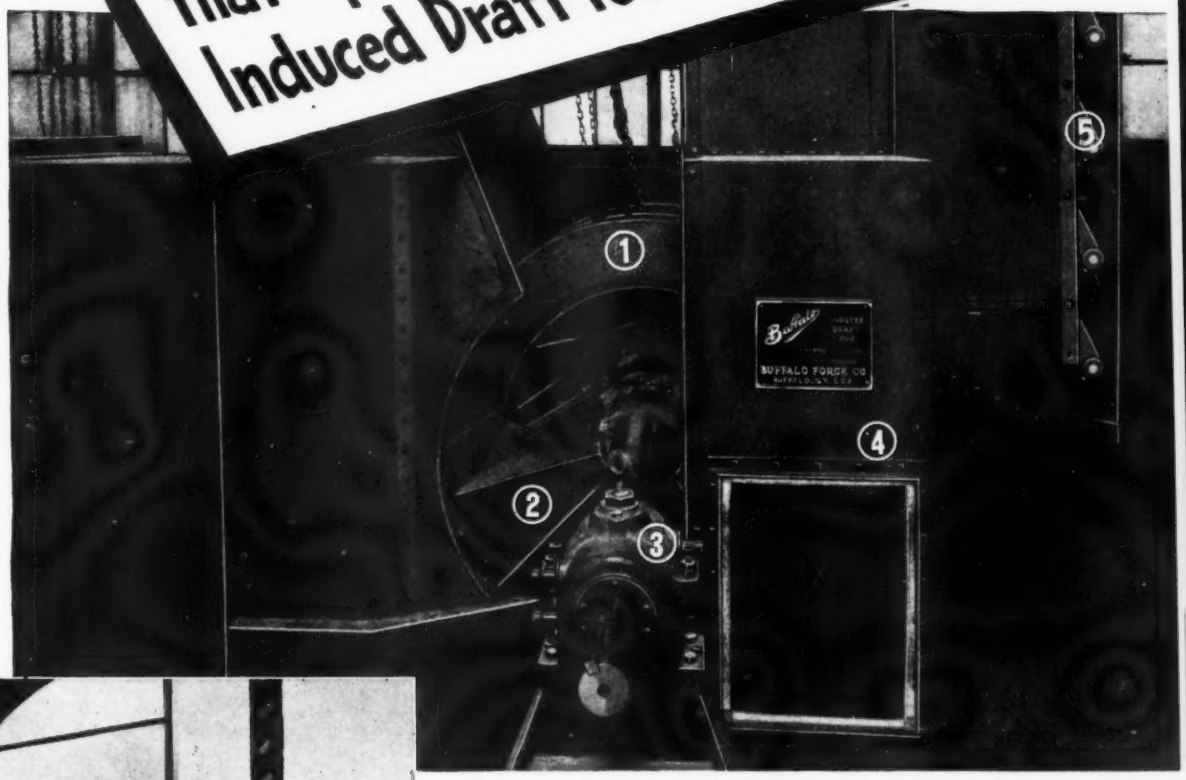


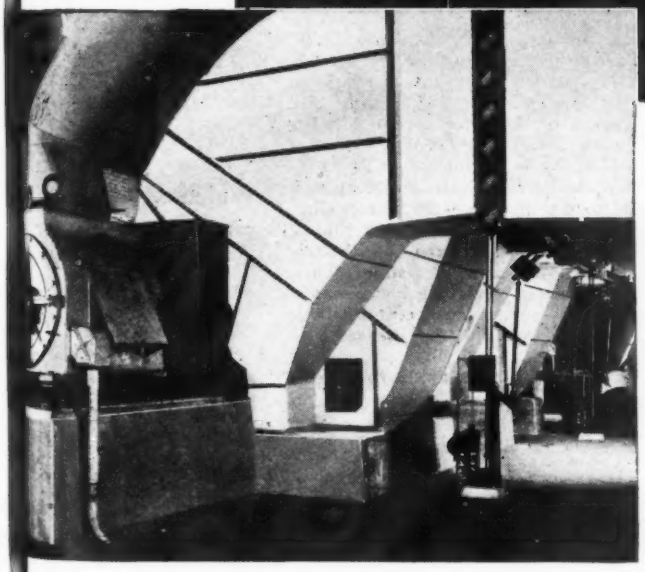
P-643

STRONG

STEAM SPECIALTIES

FARSIGHTED DETAILS that Spell Superiority in Induced Draft Performance





Above: Variable speed on these Buffalo Induced Draft Fans direct driven by constant speed motors through adjustable speed couplings.

Yours with a "Buffalo" Fan

It takes *vision* to design and build a practical fan—vision schooled by on-the-job experience. The above illustration highlights Buffalo Induced Draft Fan details which translate this kind of vision into performance superiority: (1) The dynamically balanced rotor for quiet, vibrationless operation, (2) The stationary inlet vanes, increasing efficiency and decreasing inlet box losses, (3) Self-aligning water-cooled bearings, (4) Inlet box, with convenient inspection and clean-out door removed, (5) Efficient, easy-to-control outlet damper . . . Part time-tested details like these to work on *your* draft problems—and step-up boiler efficiency!

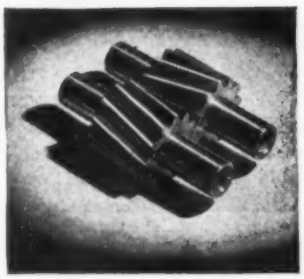
Full engineering details in Bulletin 3190-B.

"Buffalo" "First For Fans"

BUFFALO FORGE COMPANY
488 Broadway Buffalo, N. Y.
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

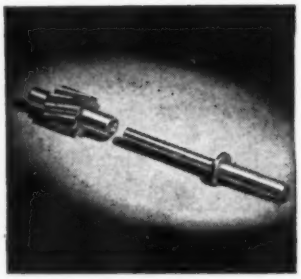
"Buffalo" INDUCED DRAFT FANS

Why Roper Pumps Last Longer!



EQUAL SIZE PUMPING GEARS

The only moving parts in Roper Rotary Pumps are these two equal size pumping gears. They operate in a case with just enough clearance to prevent wear.



HYDRAULICALLY BALANCED

Entirely separate from drive shaft, the pumping gears actually "float in operation". Any thrust or shock is absorbed by sliding joint and thrust collar.

THE ROPER PRINCIPLE

When the Roper principle of two equal size pumping gears was introduced it proved to be the most economical and satisfactory way to transfer liquid. It was new then . . . it's new today because any device that handles a job in the best way the operation can be performed is never old. Roper simplicity of design reduces wear . . . lowers upkeep costs . . . lengthens service life.

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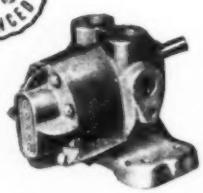

A valuable book of information on pumps and pumping problems.

GEO. D. ROPER CORP., ROCKFORD, ILLINOIS

ROPER *Rotary* PUMPS

How to design—
How to operate—
How to maintain—

A DIESEL OR GAS ENGINE POWER PLANT

This authoritative, practical book offers practicing engineers all the information necessary to make economic studies for new installations. It conveys a sound appreciation and understanding of the functional capacities and limitations of required equipment in plant use. It brings you a thoroughly workable and comprehensive guide for the designing of new installations or additions to existing installations.

DIESEL AND GAS ENGINE POWER PLANTS

THIS book focuses attention on internal-combustion engine *power plants;* it is not a treatise exclusively on engines. It covers the entire plant from its inception to completion, testing and operation. It takes up in detail the economics, design, operation and maintenance of such power plants. It includes up-to-date information which will enable the designer to estimate construction and operating costs of new plants, and it provides a standard of comparison for operating costs in existing plants. Mechanical and electrical features are presented from the viewpoint of both the plant designer and the operator.

Presents hard-to-find, up-to-date information on such topics as:—

—oil pipe-line pumping;
—power-plant structures;
—high-temperature and vapor-phase cooling;
—behavior of engine exhausts and air-intakes;
—effect of variation in exhaust and air intake pressure on engine performance;
—performance and selection of electrical equipment and auxiliaries;
—supercharging;
—convertible and gas-diesel engines.

By GLENN C. BOYER
Associate Engineer, Burns & McDonnell Engineering Co.

447 pages, 6 x 9, 182 illustrations, $4.00

Which of these 20 chapters will be of most interest to you?

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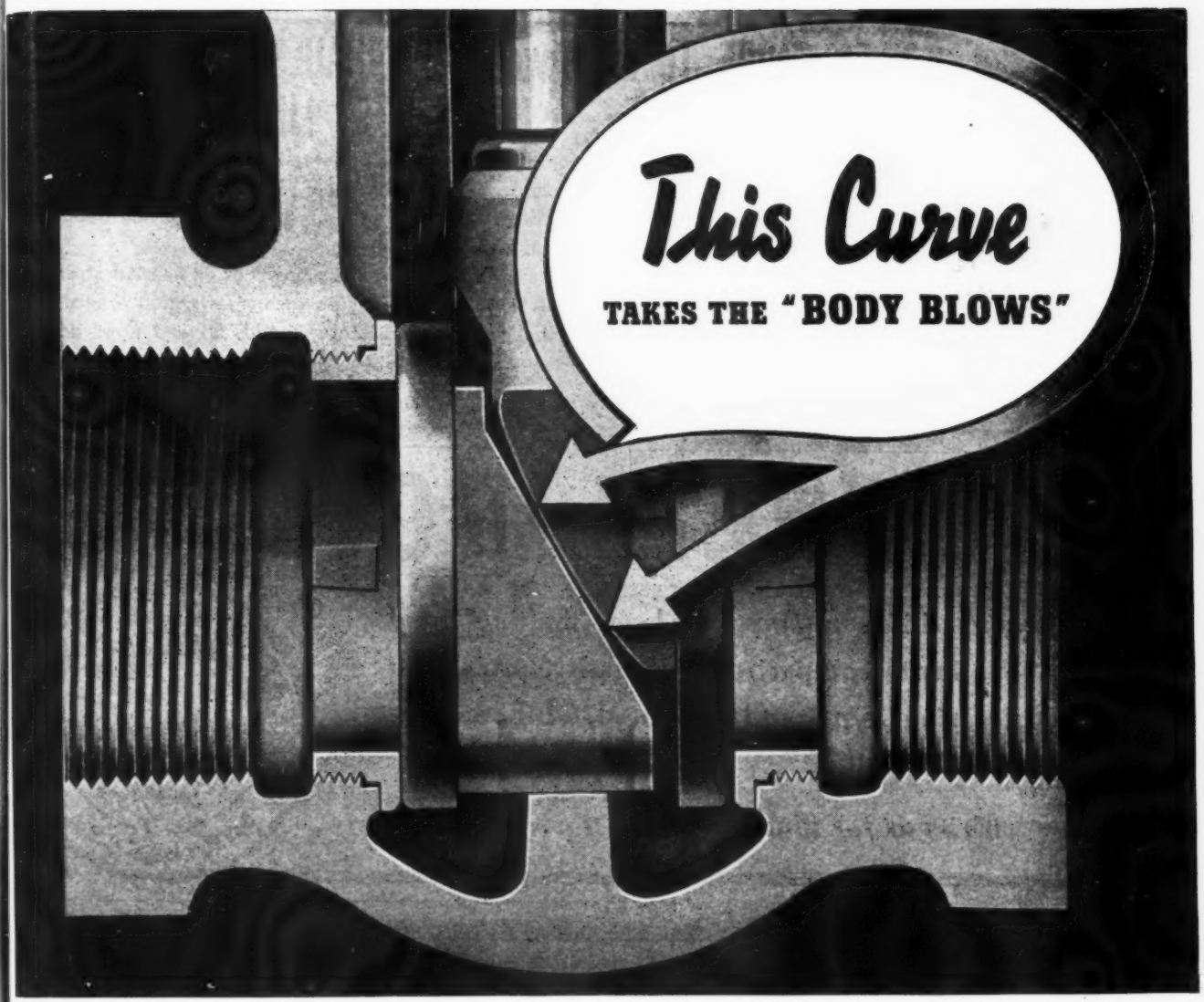
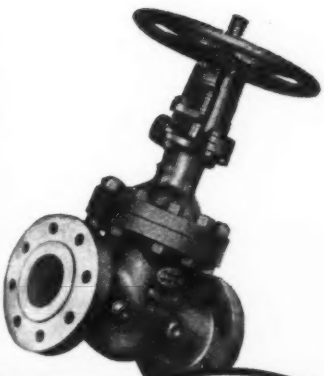


LINE strains, high temperatures and pressures will distort the body of any valve. Only Darling fully revolving double disc parallel seat gate valves have the curved wedge face and transverse bevels that permit the gate to adapt itself to out-of-line positions the valve seats may assume. There's no need to jam or force it; it fits naturally, easily and tightly.

The valve assembly consists of four simple parts—two discs, two wedges. These can easily be removed for inspection or maintenance without taking the valve from the line. When the valve closes, the two wedges force the discs firmly against the valve seats. On opening, the first quarter-turn instantly releases the wedges and frees the discs to be raised with less seating wear.

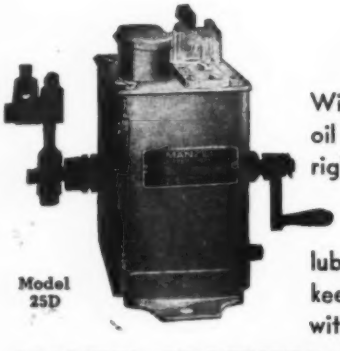
The discs are fully revolving through 360° and seat themselves in a different position each time the valve is closed. Thus wear on disc and seat is uniform, and life-long, tight closing results.

For drop-tight closing, year after year, for long, economical, trouble-free service, specify Darling Valve.



TRADE DARLING MARK

VALVE & MANUFACTURING CO.
WILLIAMSPORT, PA.



Model 25D

MORE TIME between OVERHAULS? LONGER ENGINE LIFE? Install MANZEL LUBRICATORS!

With unfailing dependability Manzel Force Feed Lubricators deliver that all-important oil film which protects cylinders and bearings from wear. They deliver exactly the right amount with each stroke, so there is no excess to cause harmful carbon deposits and loss of power. This means a saving in oil, too.

Feed on Manzel Lubricators is easily set for the amount of oil needed at each lubrication point, and once set the Lubricator needs no further attention except to keep oil reservoir supplied. The Lubricator starts, stops, speeds up and slows down with the engine.

Write for Catalog 25-D

MANZEL BROTHERS COMPANY **326 Babcock St., Buffalo 10, N. Y.**

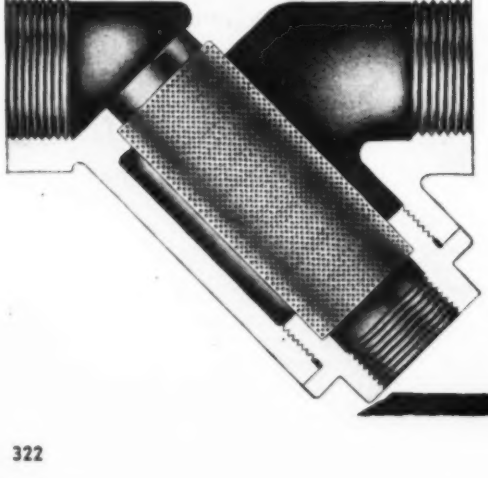
BROWNELL BOILERS

For 88 years this company has been making good boilers. We invite comparison on quality, price, and delivery of various types and sizes of fire tube boilers from 3 H. P. to 250 H. P.

Write us for illustrated bulletins.

THE BROWNELL COMPANY The World Over DAYTON, OHIO, U.S.A.

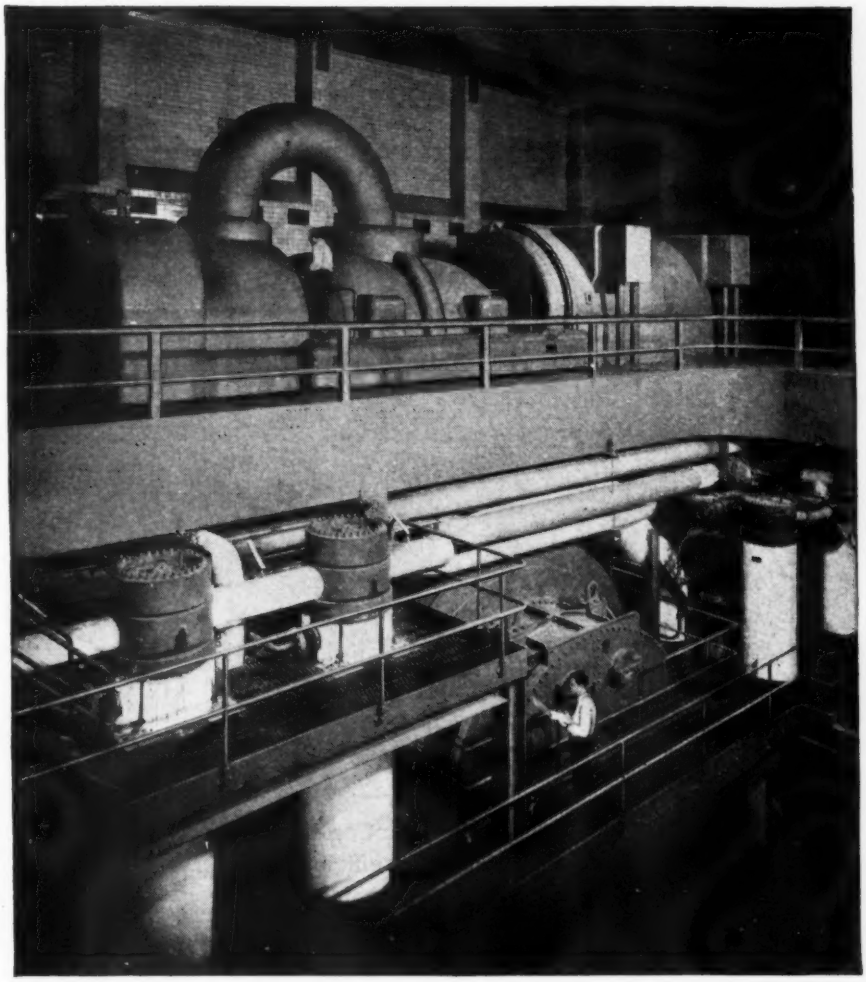
"FIGHTER PROTECTION" for your equipment



In pumps, valves, traps, meters—A little foreign matter can cause serious damage. It is wise economy and sound practice to install strainers ahead of them—to protect the equipment, to save maintenance costs, to eliminate shut-downs. Kieley & Mueller makes all types and all sizes of strainers for every steam, gas, water, oil or chemical application. They are correctly engineered to assure maximum filterage with minimum pressure drop, and are designed for easiest cleaning. Write for your copy of General Catalog 66 which includes the complete bulletin on Y, basket, straight flow, and offset strainers.

KIELEY & MUELLER, INC.
MANUFACTURERS OF PRESSURE AND LEVEL CONTROLS
NORTH BERGEN, NEW JERSEY

ALCO High-Pressure Feedwater Heaters Feature in Ultra-Modern Plant



THIS strikingly modern equipment is a recent installation in a large eastern public utility power station.

Consistent with the advanced practice evident in the installation is inclusion of five *ALCO Feedwater Heaters*. Three are high-pressure units, two low-pressure.

Two of the high-pressure ALCO heaters can be seen at the left in the above picture. Operating at 1500 lbs. pressure, these heaters heat the water to 430 degrees final temperature.

ALCO feedwater heater engineering has been conspicuously successful in high-pressure service. Several ALCO installations are operating successfully at 2200 lbs. pressure.

It should be noted that each of the high-pressure ALCO units in the installation shown is equipped with *ALCO Vertical Condensate Drain Cooler*. ALCO's development of a thoroughly reliable drain cooler for vertical operation is only one example of ALCO's contribution to better feedwater heater design.

All of these five ALCO feedwater heaters have *ALCO Clamp Ring Joints*—another ALCO specialty which is greatly promoting maximum continuity of service.

Continued selection of ALCO feedwater heaters is the best evidence of their superiority. ALCO Bulletins covering this equipment will be promptly sent on request. ALCO feedwater heater and heat exchanger engineering specialists are available for consultation.

AMERICAN LOCOMOTIVE COMPANY

ALCO PRODUCTS DIVISION

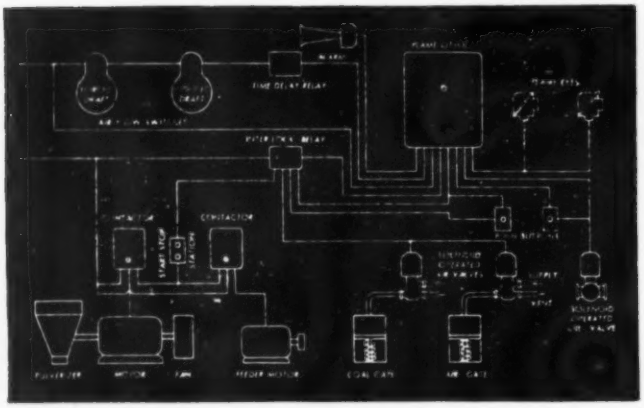
30 Church Street, New York 8, N.Y., Dunkirk, N.Y.

ALCO PRODUCTS

HEAT EXCHANGERS • PRESSURE VESSELS • PREFABRICATED PIPING

COMBUSTION SAFEGUARD

for Combination PULVERIZED COAL and OIL BURNER PROTECTION



Combination pulverized coal and oil burner protected by Wheelco Flame-otrol with complete purging cycle and safety shut-off features.

The Wheelco Flame-otrol (Electronic Combustion Safeguard) operates with equal efficiency on gas, oil, powdered coal, or any combination of these fuels. The Flame-otrol eliminates explosion hazards by preventing fuel and explosive product accumulation in the combustion chamber. Fuel, to the burner, is shut off instantly upon flame failure, or should any condition develop within the instrument itself, which might interfere with its operation. It also offers definite protection against carelessness and negligence of inexperienced operators. Flame-otrols are available with automatic or manual ignition, time delay for purging, or other desirable sequences. ***Request Bulletin L-2***

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INSTRUMENTS COMPANY

863 W. HARRISON STREET CHICAGO 7, ILLINOIS

CREATORS OF "ELECTRONIC PRINCIPLE" TEMPERATURE CONTROLS

Are you equipped to hold your job?—to get a new one?

The men who are keeping their jobs today—who are not feeling the whip of competition—are those who have kept one jump ahead of their jobs. They are the men who are equipped with a thorough-going and growing knowledge of the business they are in.

It works in the power plant field as well as in any other. Some men fit themselves to do a little more than their job calls for. They fit themselves to do a little more than the other fellow. They make a steady effort to equip themselves with the best kind of job insurance there is—KNOWLEDGE.

How about you? Do you know how quickly knowledge will pile up—how quickly you will become more valuable—if you spend a few minutes a day, regularly studying sound books like the McGraw-Hill Library of Power Plant Practice? Do you know how easily it can be managed, paying only a few cents a day, while you use the books?

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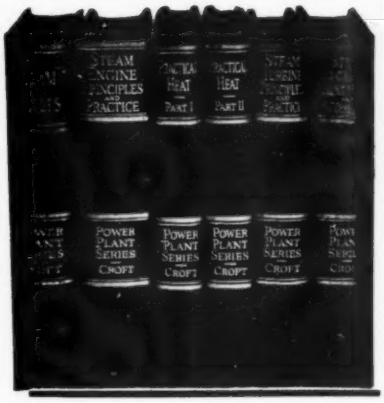
POWER PLANT PRACTICE

(6 volumes—2,477 pages, 2,404 illustrations)



The Library of Power Plant Practice is the standard of the power plant field. It is accurate — it is thorough — it is complete. It is the result of years of experience with power plant problems. The man who has it has the best. The Library covers the whole field—nothing is omitted. The solution of every problem is plainly worded or explained with a clear illustration. The little stickers and the big troublesome problems are all worked out in advance for you. There can be only one result from studying these books a few minutes each day — more money in your pocket.

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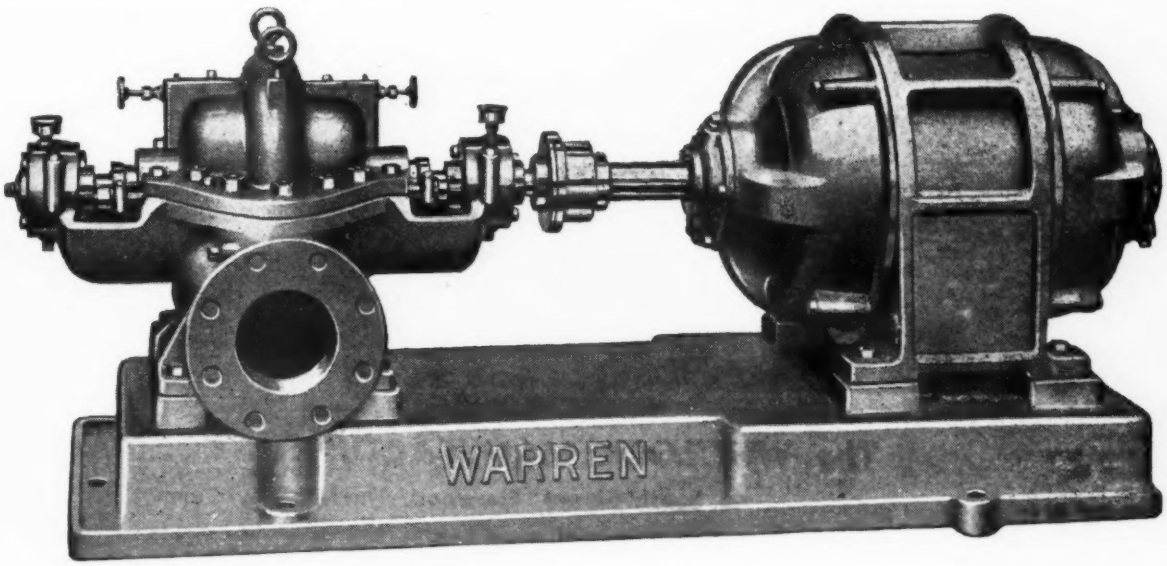
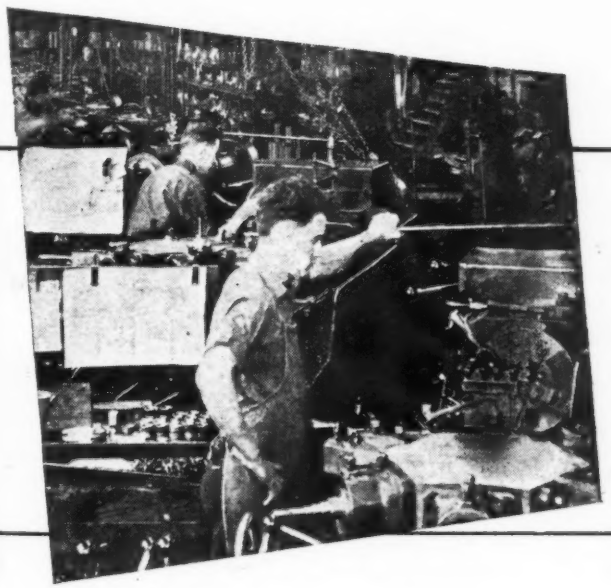
Here's A High Speed
WARREN PUMP
That Is Well Worth Looking Into Now





The boys in the Warren Acme Lathe Department like *all* Warren employees, are proud of our Army-Navy "E" Award . . . proud of the star recently added for continued production efforts.

Since more and more Warren Pumps are now being made available for commercial purposes, a timely tip is to look into Warren Pumps for your own future use.

The Warren Pump featured here is a single stage double suction pump, type DBH, specially designed for high speed operation and heads up to 300 feet.

Its *impeller* is accurately machined and balanced to insure freedom from vibration . . . with all water passages hand finished. Case *rings* are of cast bronze of the nozzle type with joint between case rings and impeller forming a labyrinth seal . . . securely held in place by tongue and groove lock in the lower half of pump casing. *Bearings* are of ball type held against pump shaft shoulder by means of locknuts and washers.

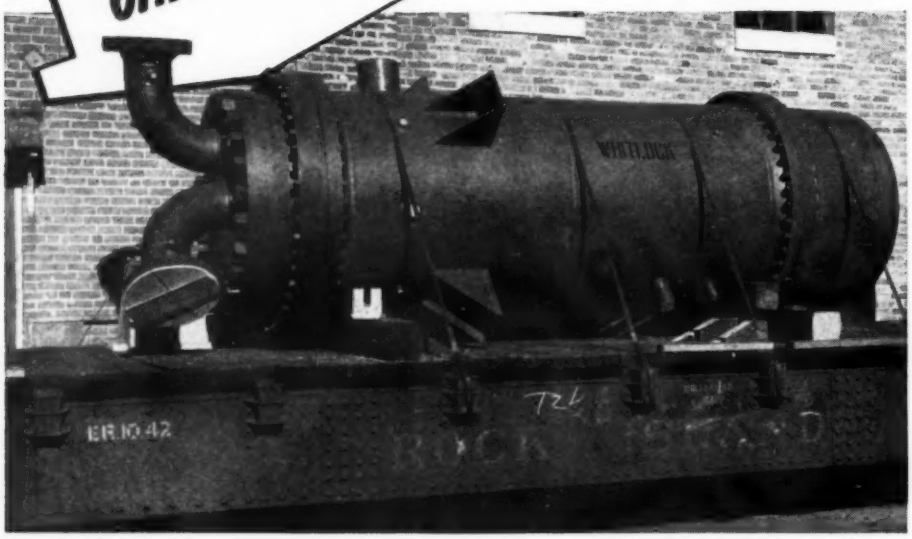
Every Warren Pump is given a complete running test and all guarantees verified before shipment. Write for further information about Warren Pumps as they would apply to your particular problems.

WARREN STEAM PUMP CO., INC.
WARREN, MASSACHUSETTS

WHITLOCK

FEED WATER HEATERS

MONO-BLOC CHANNEL



WHITLOCK Engineers, aware of the advantages of reducing the pressure area of the channel, developed the mono-bloc design which decreases the outside diameter of the channel to a minimum resulting in:

1. Reduced bolt load on shell flange since channel is bolted directly to tube sheet and not through tube sheet to shell flange.
2. Decrease in thickness of tube sheet and channel.
3. Reduction in total pressure load.
4. Reduction in size and number of bolts.
5. Fewer bolted joints in feed water circuit.

Engineered design of this kind is yours for the asking by specifying WHITLOCK.

Overall dimensions—
63" O.D. x 221½" Long
Net Weight—45,000 lbs.
Surface—2650 sq. ft.
Design Pressure—Shell 150 lbs.
Tubes 900 lbs.

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District Offices in New York, Boston, Chicago, Philadelphia, Detroit, Richmond.
Whitlock Equipment (Whitlock-Darling) is manufactured in Canada by Darling Brothers Ltd., Montreal

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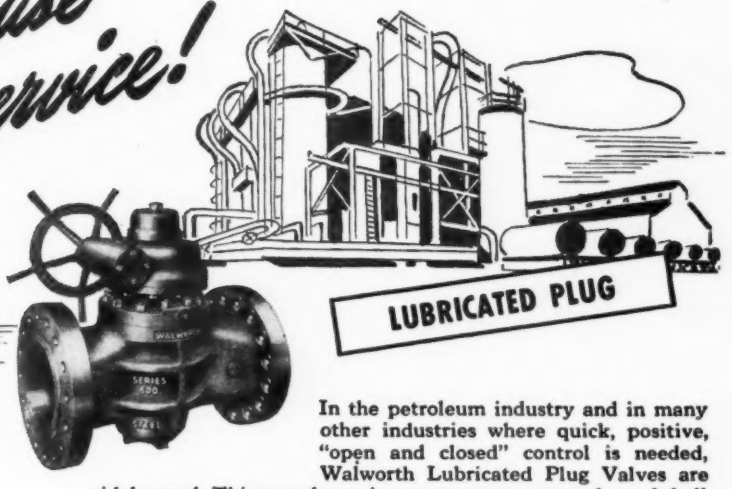
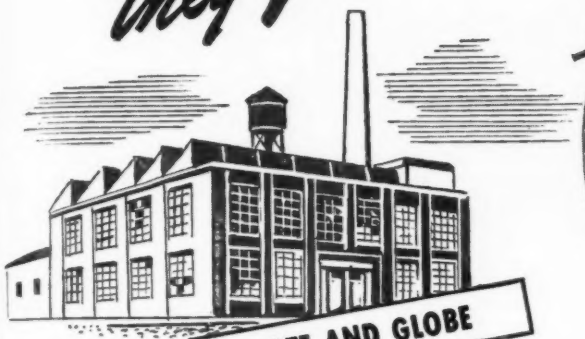
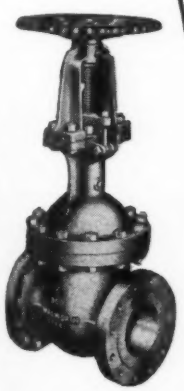


LUBRICATED PLUG

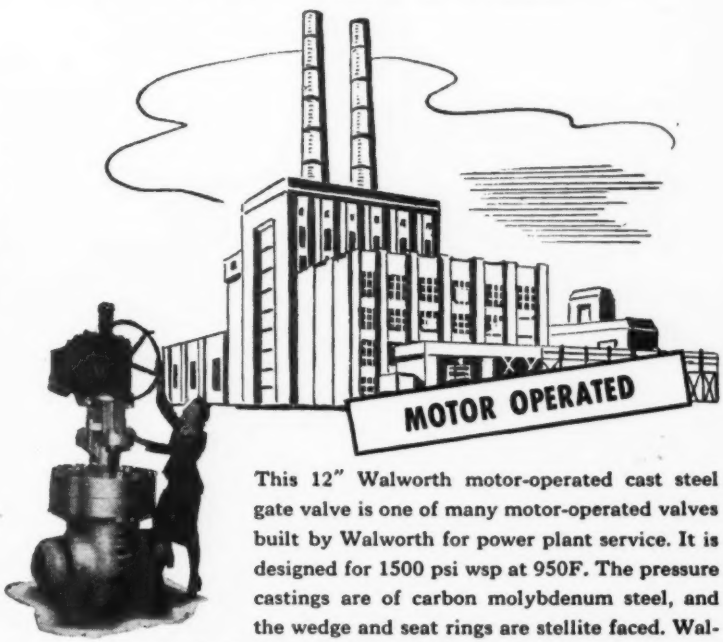
In the petroleum industry and in many other industries where quick, positive, "open and closed" control is needed, Walworth Lubricated Plug Valves are widely used. This one shown is a worm gear operated, steel, ball bearing type valve for 600 lbs. pressure. Other Walworth Steel Lubricated Plug Valves are made in sizes from ½" to 24", for pressures from 125 to 5000 psi, and for vacuum.



GATE AND GLOBE



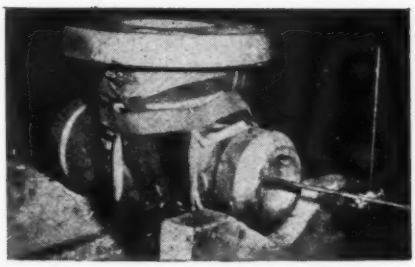
Walworth manufactures gate and globe type cast steel valves for 150 to 1500 psi wsp – Oil, Water, and Gas pressures up to 5000 lbs. The Walworth Series 300 gate valve shown is made in sizes from 2" to 24". Its streamlined ports, deep stuffing box, oversize stem, and heavy wall thickness assure long and reliable service.



MOTOR OPERATED

This 12" Walworth motor-operated cast steel gate valve is one of many motor-operated valves built by Walworth for power plant service. It is designed for 1500 psi wsp at 950F. The pressure castings are of carbon molybdenum steel, and the wedge and seat rings are stellite faced. Walworth Steel Valves can be furnished with air, gas, or electric motor operating units and with or without by-passes as required.

RADIOGRAPHIC INSPECTION



For many years Walworth has been using gamma-ray technique for the study and improvement of the heavier and varying sections of steel valves and fittings. This is just one of many ways in which Walworth research and engineering pre-prove Walworth products.

Walworth manufactures a complete line of bronze, iron and steel valves and fittings. For a detailed description of the entire Walworth line, write on your company letterhead for Catalog 45.

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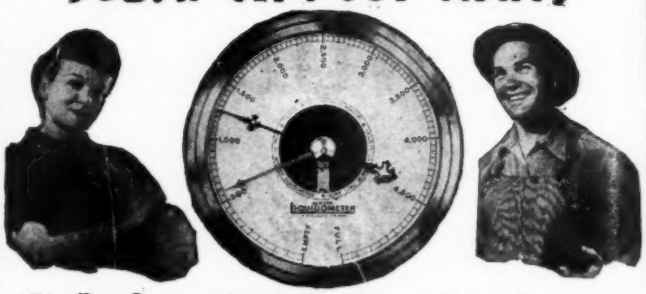

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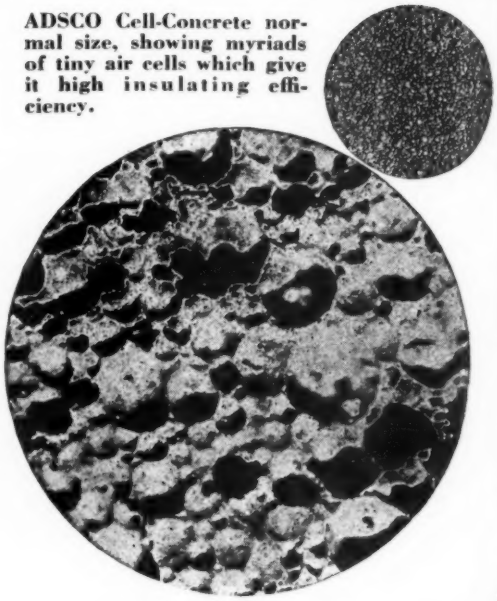
ADSCO Cell-Concrete normal size, showing myriads of tiny air cells which give it high insulating efficiency.



ADSCO Cell-Concrete magnified fifteen times, showing uniform distribution of air cells throughout material.

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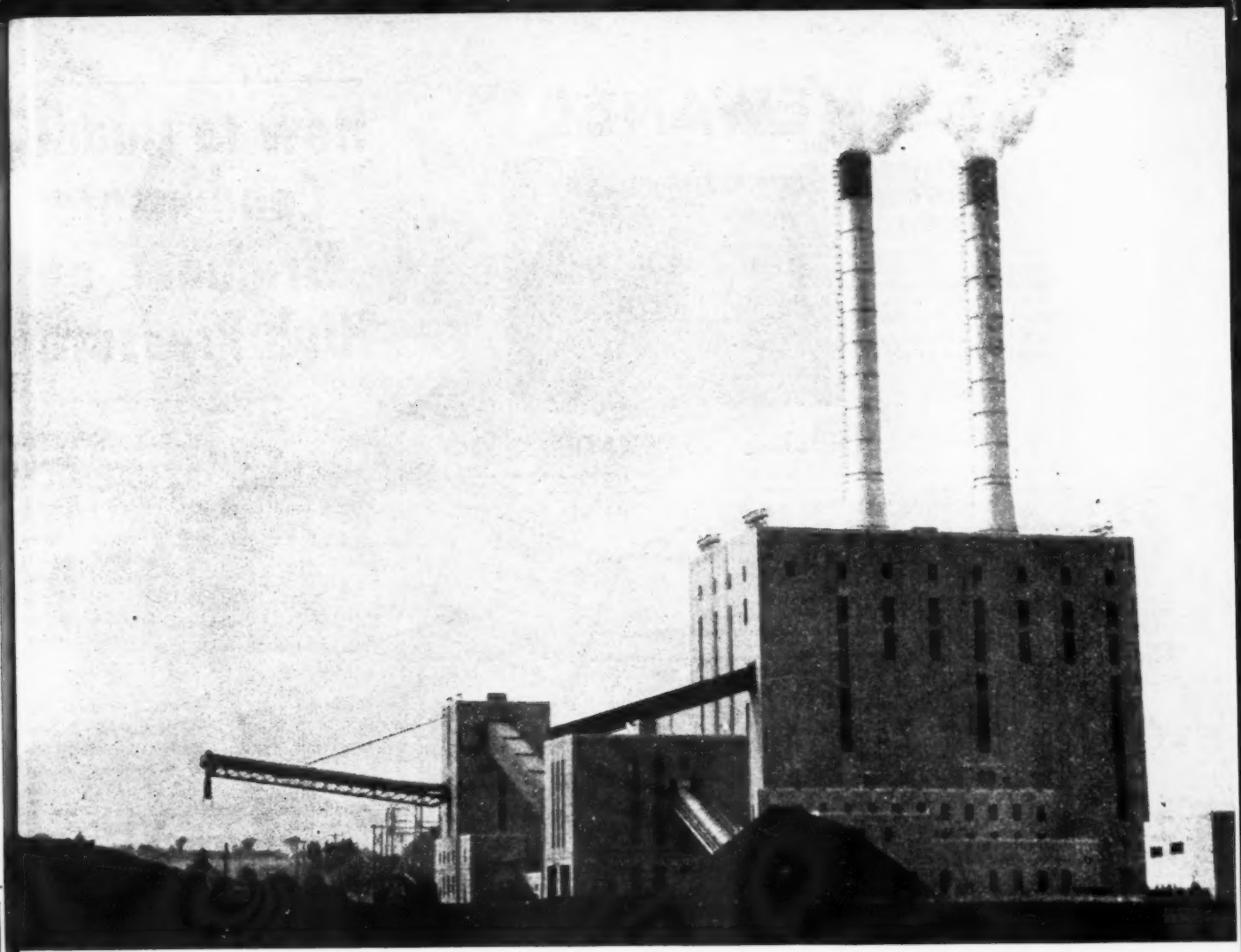

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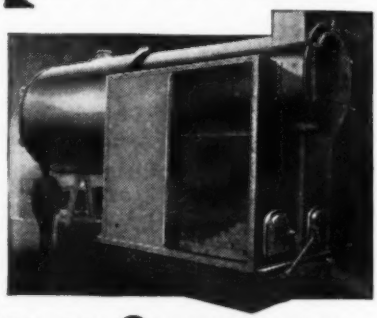

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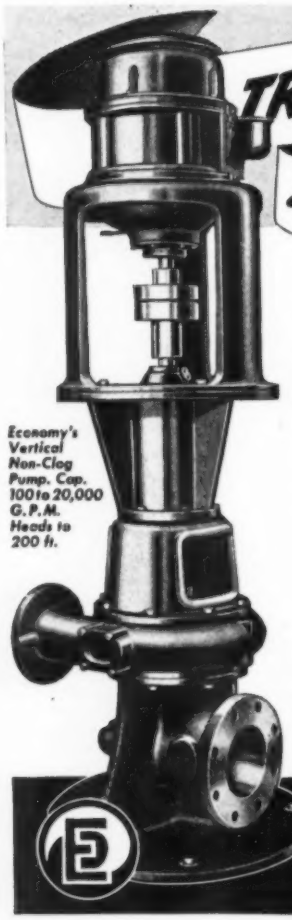

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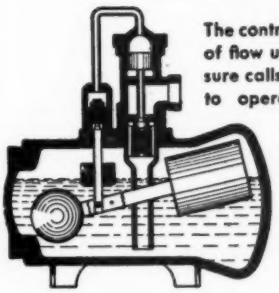
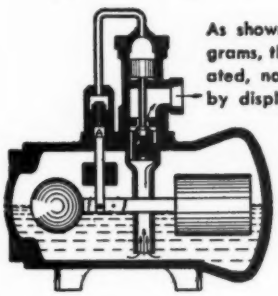
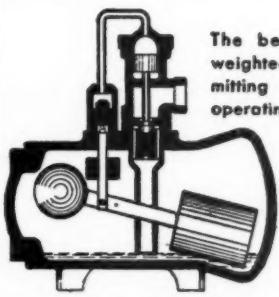


The control of a high rate of flow under high pressure calls for great force to operate the valve.

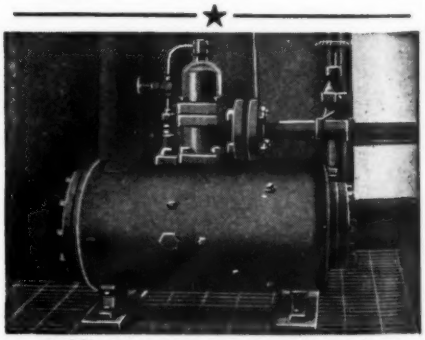
In the Cochrane Discharger this force is provided by a piston actuated by a pilot valve.



As shown in these diagrams, this pilot is operated, not by floats but by displacement bodies of different densities at either end of a beam which tilts with the rise and fall of the water level.



The beam opens the weighted pilot valve admitting steam to main operating valve which instantly opens main discharge valve to full opening, avoiding wire drawing or chatter.



Publication 2935 gives complete data.

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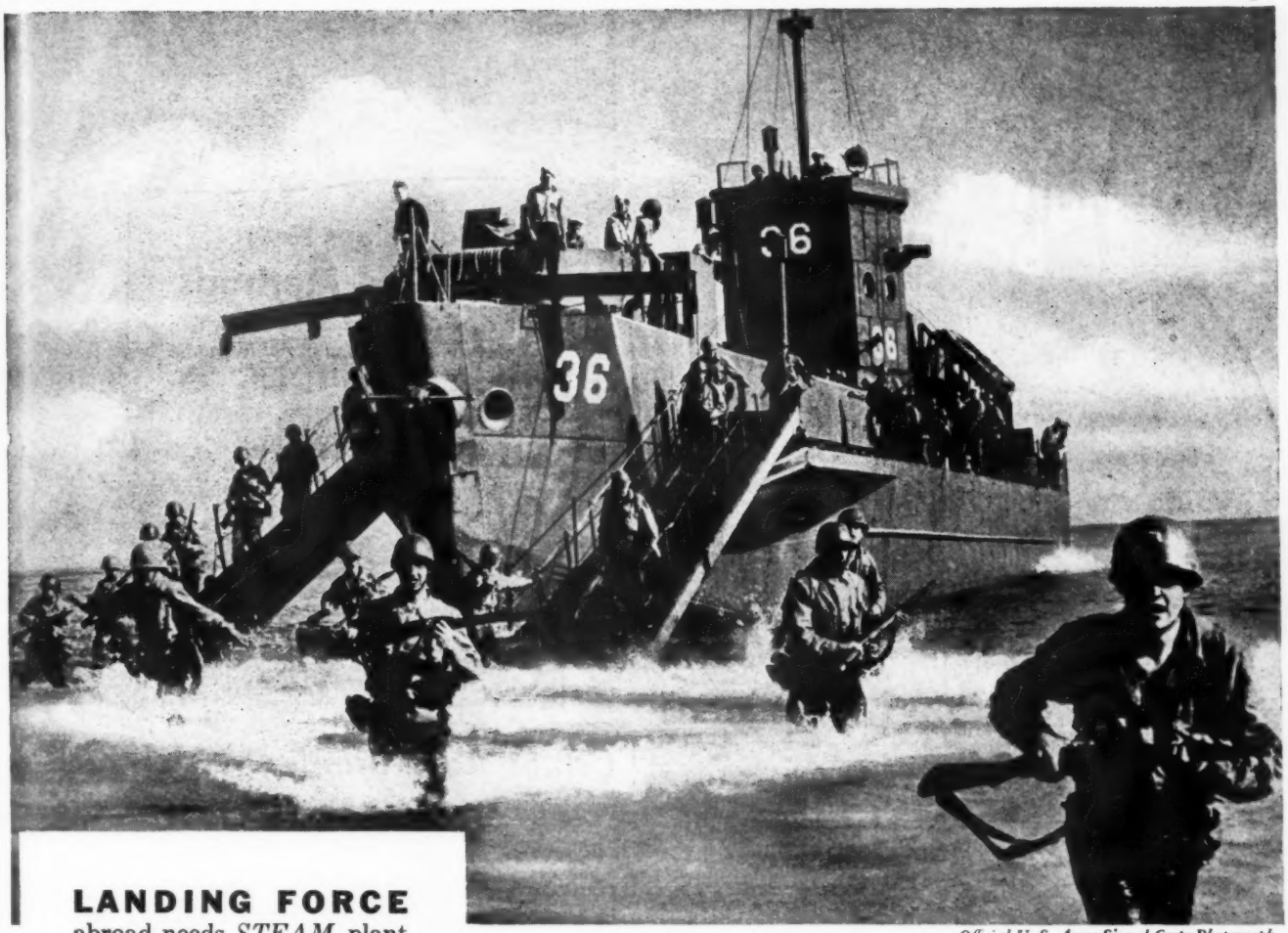

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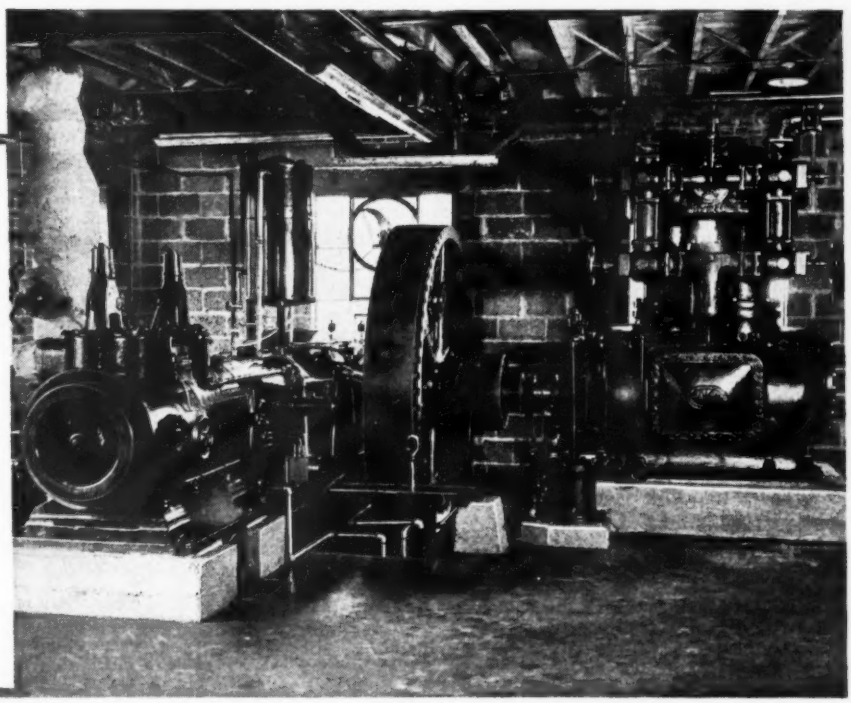

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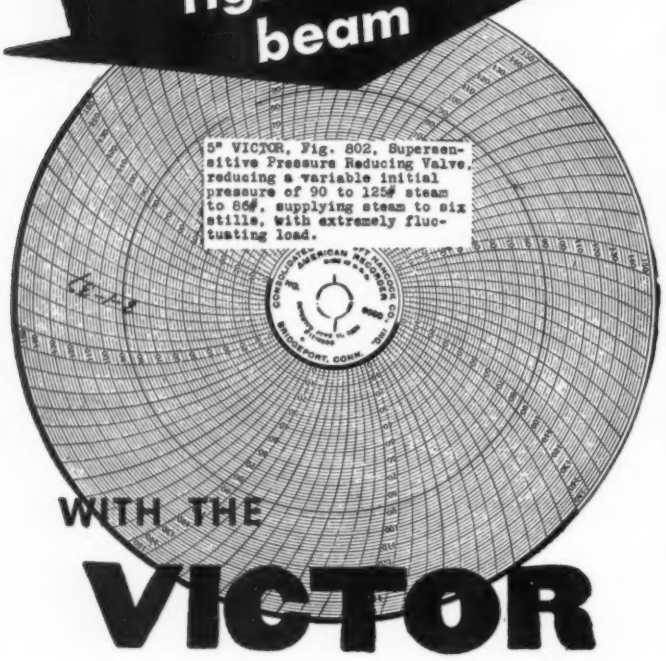
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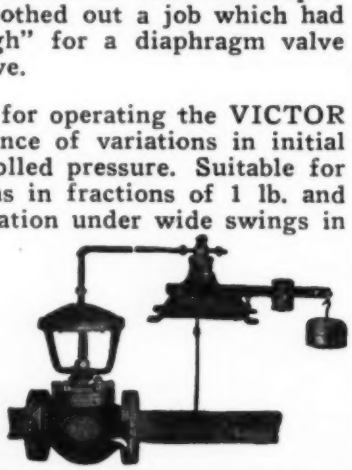

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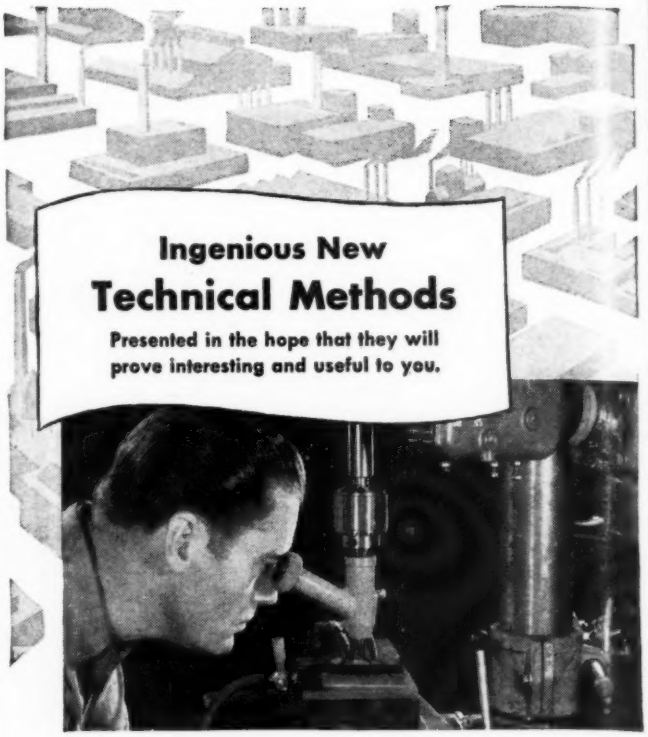

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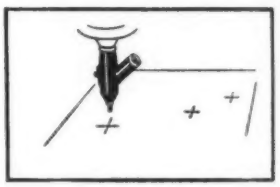
The Center Scope's easy accuracy eliminates many human errors, as the operator can see just what the cutting tool will do before it is actually fed into the work. It increases production, improves efficiency and prevents spoilage. There is no pressure on the work piece nor is it subject to wear or changes in temperature—for the Center Scope never touches the layout.

The Center Scope enables the operator to easily and quickly locate edges to a spindle axis, set-up faster and compensate for run-out. It saves vital hours in checking, inspecting and measuring when mechanical methods and tools are impossible to use. Its 45 x magnification allows operator to see ".001" and requires no technical knowledge or training to operate.

While there is nothing particularly new or ingenious about Wrigley's Spearmint gum, it is proving useful to millions of people in many new ways. Workers in war plants everywhere have found it helps keep them alert and relieves nervous tension and dry mouth while they are on the job.

You can get complete information from the Center Scope Instrument Company, 351 South LaBrea Ave., Los Angeles, Calif., or Kearney & Trecker Products Corporation, Milwaukee, Wisconsin.



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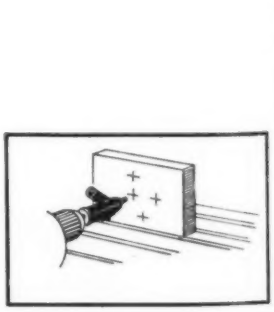

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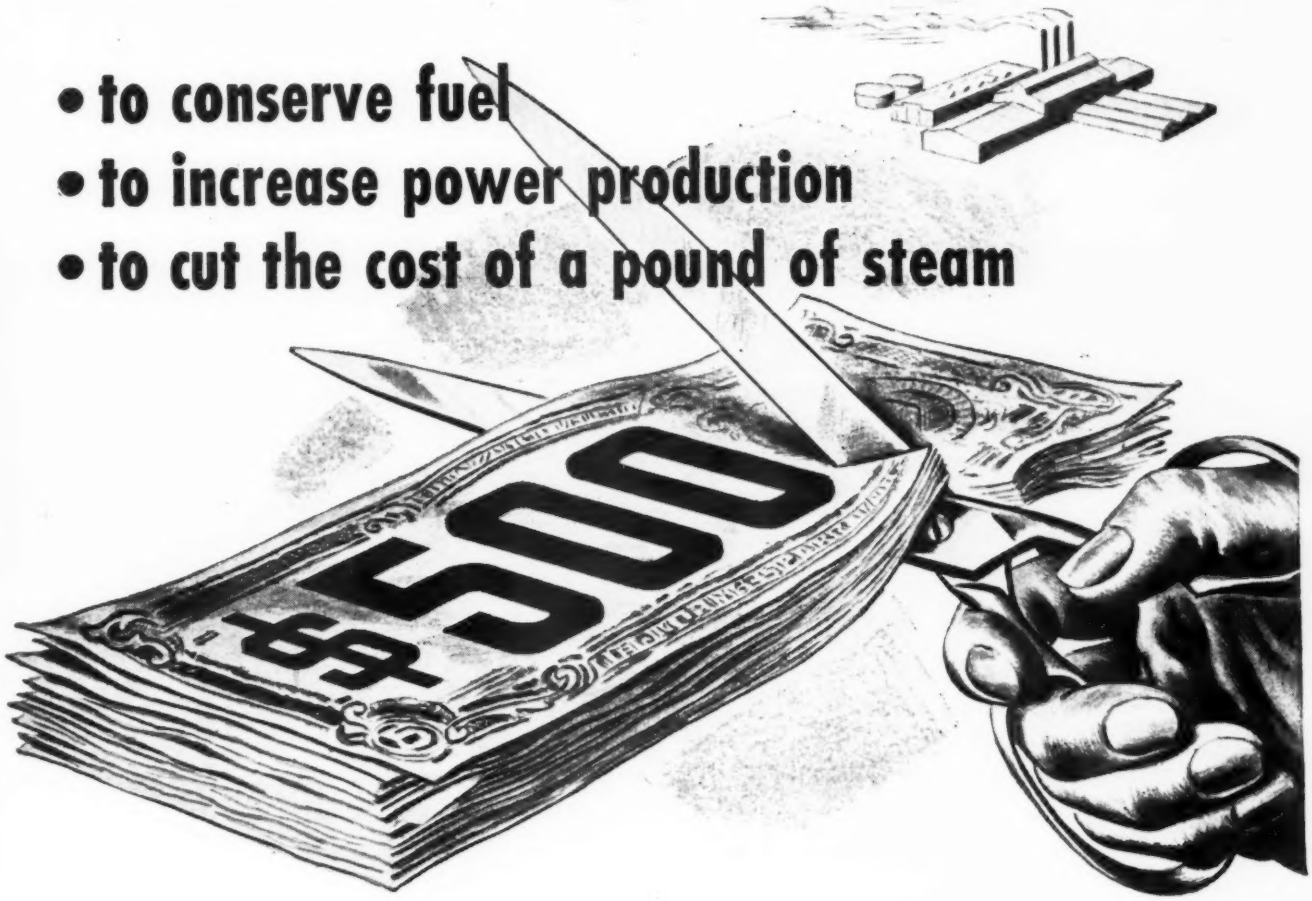

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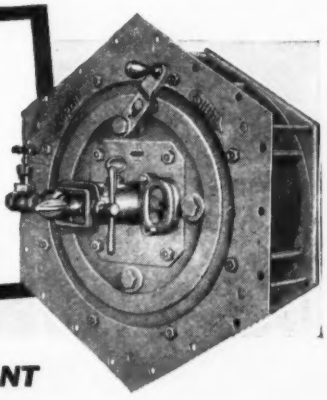

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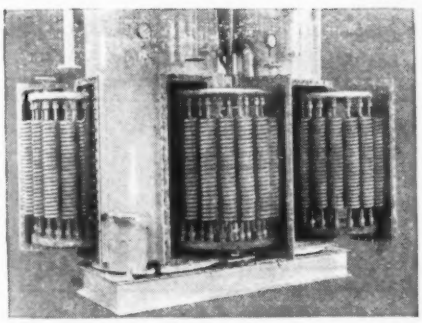

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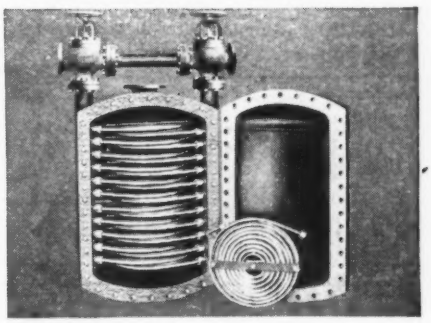

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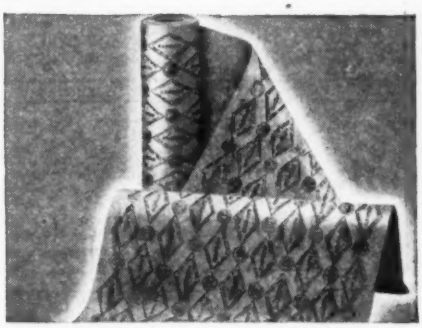

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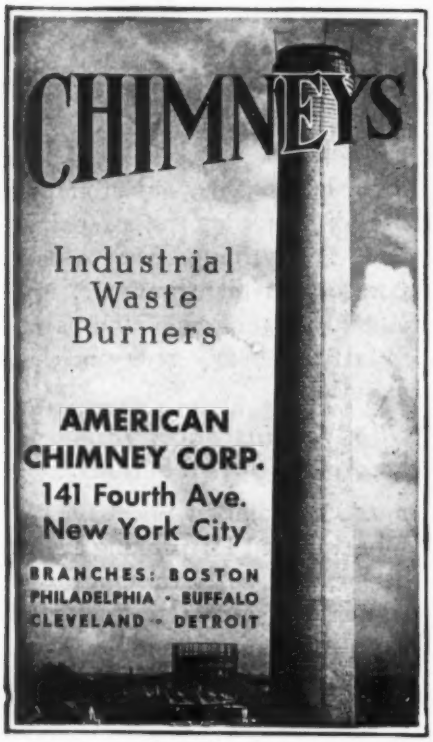

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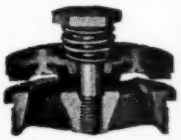

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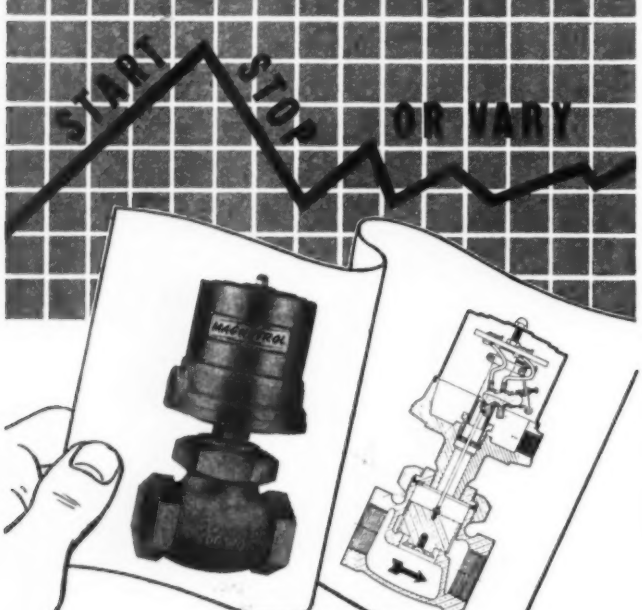

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(Continued on page 362)

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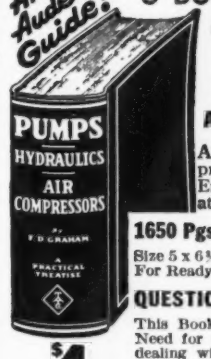

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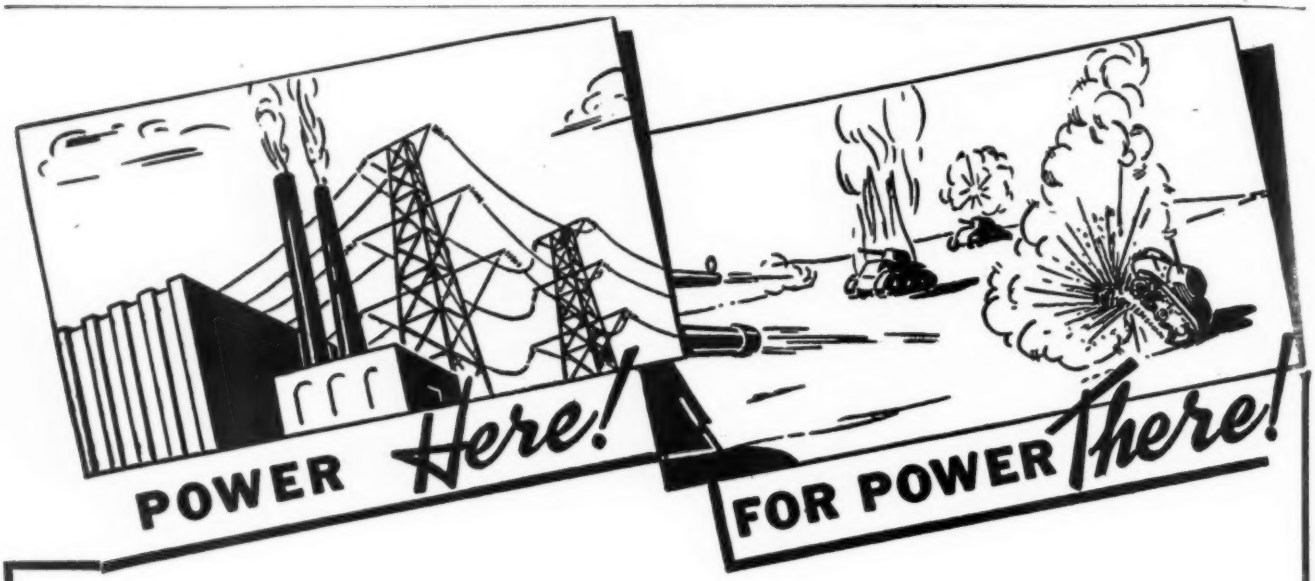

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1—75 HP, 720 RPM, 440 volt, Westghse., slip ring.
1—75 HP, 720 RPM, 440 volt, G.E., sq. cg.
2—75 HP, 1200 RPM, 2200 volt, G.E., Vertical.
1—50 HP, 900 RPM, 440 volt, G.E., sl. rg.
1—50 HP, 900 RPM, 440 volt, G.E., sq. cg.

MOTORS—D.C. 230 VOLTS

2—450 HP, G.E., 400 RPM, Type MPL Form 1-F.
1—250 HP, 760 RPM, Electro Dynamic.
2—150 HP, Westghse., 550 RPM, Type SK.
1—150 HP, 750 RPM, Electro Dynamic.
1—125 HP, 600 RPM, Westinghouse, SK.
1—100 HP, G.E., 575 RPM.
1—100 HP, 625 RPM, G.E.
1—80 HP, Crocker-Wheeler, 600 RPM, Type CMC.
1—75 HP, G.E., 575 RPM, Type C, Sprague; with spare armature.
1—65 HP, 1000 RPM, G.E., Type RC.
8—50 HP, Crocker-Wheeler, 700 RPM, Type CM.
1—65 HP, G.E., 625 RPM, Type DLC-65, Form A.
1—50 HP, 750 RPM, Westghse., Type SK.
1—50 HP, 700 RPM, Crocker-Wheeler.
1—40 HP, G.E.-Sprague, 700 RPM, Type LC.
1—40 HP, 775 RPM, Westinghouse.
1—40 HP, 300 RPM, G.E.
1—30 HP, 750 RPM, G.E., type RC.
1—30 HP, G.E., 750 RPM, Type RC-14, Form A.
1—30 HP, G.E., 1100 RPM, Type RC-31B, Form A-21.
1—35 HP, G.E., 650 RPM, Type RC-15.
1—30 HP, G.E., 625 RPM, Type C.
1—25 HP, Westghse., 600 RPM, Type SK.
2—25 HP, G.E., 775 RPM, Type RC-13.
1—20 HP, G.E., 800 RPM, Type RC-13, Form A.
1—15 HP, G.E., 800 RPM, Type RC-11.

TRANSFORMERS

2—400 KVA, G.E., 4156-250/480 v., Scott taps.
3—300 KVA, Pittsburgh, 7800/440 volts.
3—150 KVA, G.E., 33,000/2300/4000 Y.
3—100 KVA Westinghouse, 11,430/250 volts.
1—100 KVA, Pittsburgh, 1375/2750-110/220 volts.
3—100 KVA, Westinghouse, 13200-250 volts.
3—75 KVA, G.E., 13,500-750/440 volts.
3—75 KVA, General Electric, 2200/220/110.
1—75 KVA, G.E., 3 phase, 4156Y—120/208Y.
3—50 KVA, G.E., 2200/220/110.
2—50 KVA, Pbgh. 7500/15000 volts-110/220 volts.
3—37½ KVA, G.E., 2200/220/440.
2—30 KVA, Allis Chalmers, 3 phase, 4156Y/120/208Y
1—25 KVA, G.E., 220/110-220/110 volts.
2—15 KVA, G.E., 2300-115/230 volts.

MOTORS—VARIABLE SPEED 230 VOLTS

2—100 HP, 475/1375 RPM, Electro Dynamic.
1—90 HP, 470/940 RPM, General Electric.
1—75 HP, 525/1575 RPM, Electro Dynamic.
1—35 HP, 500/1500 RPM, Westinghouse.
1—35 HP, 350/1050 RPM, Electro Dynamic.
1—30 HP, 225/900 RPM, Crocker Wheeler.
7—25 HP, Westinghouse, 650/2200 RPM, Type SK-110L.
2—25 HP, 300/900 RPM, Electro Dynamic.
1—20 HP, 750/1500 RPM, General Electric.
1—15 HP, 300/1200 RPM, G.E.
1—13/18 HP, 350/1200 RPM, Electro Dynamic.
1—5 HP, 600/1200 RPM, General Electric.
1—5 HP, 450/1800 RPM, Crocker Wheeler.
1—5 HP, 400/1600 RPM, Diehl.
1—5 HP, 225/900 RPM, Electro Dynamic.

TURBO-GENERATORS

600 KW Terry dual bleeder condensing Turbine only.
1—500 KW, G.E., 3 ph., 60 cy., 430 volt, bleeder.
1—375 KVA, Westghse., non-condensing.
1—300 KW, G.E., 3 ph., 60 cy., 220 v., cond.
1—200 KW, G.E., 3 ph., 60 cy., 220 v., cond.

Hemphill FOR POWER

J. L. HEMPHILL & COMPANY

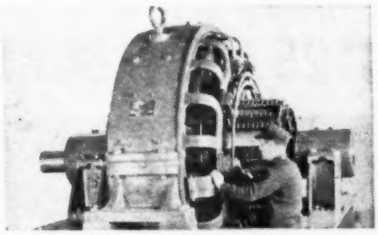
1602 53rd ST., NORTH BERGEN, N. J.

PHONE NEW YORK—LONGACRE 5-3227 NEW JERSEY—UNION 3-2600

Step Up Your Power

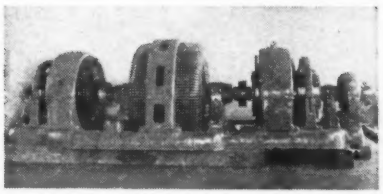
QUICK WITH

Stock Equipment



Shipped as fast as conditions allow

WRITE—Better Still—WIRE



MOTOR GENERATOR SETS

3 Phase 60 Cycle

1—1500 KW G.E., 275 V. D.C. to 2100 H.P., 2300 V.

1—1000 KW G.E., 275 V. D.C. to 1400 H.P., 4150/2300 V.

1—1000 KW WHSE., 600 V. D.C. to 1400 H.P. 4000 V.

1—500 KW G.E., 600 V. D.C. to 700 H.P. 13200/6600 V.

1—500 KW G.E., 250 V. D.C. to 1000 KVA, 2200 V. Syn. Motor.

1—400 KW G.E., 250/275 V., D.C. to 600 HP, 2300 V.

1—300 KW G.E., 250/275 V. D.C. to 400 KVA 440 V.

1—115 KW G.E., 250 V. D.C. to 175 H.P., 440 V. Ind. Motor.

1—100 KW WHSE., 250 V. D.C. to 159 KVA, 2300 V.

1—75 KW G.E., 125 V. D.C. to 120 H.P., sq. cg. 2300/4000 V.

1—50 KW G. E., CD, 125 V. D.C. to 75 H.P., sq. cg., 2300/4000 V.

1—40 KW WHSE., 230 V. D.C. to 45 KVA 2300 V.

1—35 KW A. B. See 230 volt D.C. to 50 H.P. 220 volt sq. cg. motor with exciter.

TURBO GENERATOR SETS

1—500 KW Whse. 625 Kva. 440 V. 3 ph. 60 cy. 3600 RPM with Parsons 145/175 lb. cond. turbine complete with jet cond. and access.

1—75 KW Ridgeway 250 V. D.C. with Terry turbine 180 lb. pressure with 12 lb. bk. pres., 2000 RPM.

A. C. GENERATORS AND SYNO. MOTORS

3 Phase—60 Cycle

HP or KVA	Make	Type	Volts	Speed
2—2100	G.E.	ATI	2300	514
1—1000	Whse.		2300	900
1— 750	G.E.	ATI	220/440	900
1— 600	G.E.	ATI	220/440	900
1— 625	Whse.		480	900
1— 500	G.E.	TS	440	360
1— 225	G.E.	ATB	220	600
1— 159	Whse.		2400	900
1— 150	Whse.		4000	1800
1— 100	Whse.		2400	900
2— 100	Whse.		2300	1800

A. C. MOTORS

3 Phase—60 Cycle

SLIP RING

HP	Make	Type	Volts	Speed
1—1200	Cr. Wh.	801Q	2300	237
1— 800	Al. Ch.	ANY	440	885
1— 800	Whse.	CW	440	357
2— 600	G.E.	IP	440/2200	720
1— 450	Whse.	HW	2200	875
1— 400	Al. Ch.	ANY	440	1200
1— 400	Al. Ch.	ANY	2300	505
1— 400	G.E.	IP	440/2200	600
1— 350	G.E.	MT-442	2300/4000	257
1— 300	G.E.	IM	440	720
1— 300	Whse.	CW	440	585
1— 250	G.E.	I-17B	440	450
1— 250	G.E.	MT	4000/2300	257
1— 200	G.E.	IF-M	2200	1750
1— 200	Whse.	CW	2200	514
1— 200	G.E.	I-M	440	600
1— 150	G.E.	IM	2200	695
1— 150	G.E.	MT-564	440	600
1— 150	G.E.	IM-17B	2200	290
1— 100	G.E.	IM	220	1750
1— 100	G.E.	MTC-5546	220/440	860

A. C. MOTORS

SQUIRREL CAGE

HP	Make	Type	Volts	Speed
1—500	G.E.	1-17B	2200	690
1—400	Whse.	CS-1104A	2200	585
1—300	Whse.	CS	550	580
1—300	G.E.	IK	440/2300	600
1—200	G.E.	IK	2300	490
1—175	G.E.	IK	440	900
1—150	Lincoln		440	1200
1—150	G.E.	IE	440	1200
1—150	Al. Ch.	AN	440	1765
1—100	Whse.	CS	550	1750

GEAR REDUCTION UNITS

1—2100 H. P. Whse. 1800/360 RPM.
1— 943 H.P. G.E. 5306/1200 RPM
1— 450 H.P. G.E. 3600/1200 RPM

THE BELYEA REPUTATION PROTECTS YOU!

ROTARY CONVERTERS

3 Phase, 60 Cycle

Qu.	KW	Make	Speed	DC V.	Trans. V.
1	1500	Whse.	720	600	2300
1	1500	Whse.	600	600	11500
1	1250	G.E.	720	250	2300
1	1000	G.E.	900	600	13200
1	1000	Whse.	900	600	11000
2	750	G.E.	1200	600	2300
1	750	Whse.	720	250	6600/2300
1	500	Whse.	1200	600	13200/2300
2	375	G.E.	1200	250	6600/2300
3	300	G.E.	1200	600	2300

3 Phase, 25 Cycle Booster Type

2	1500	G.E.	500	225/275	13200/6600
1	500	G.E.	750	225/275	13200/6600

All units can be furnished with AC and DC controls

TRANSFORMERS

60 Cycle

KVA	Make	Ph.	Type	Voltages
6—1667	Pitts	1	OISC	13200x2300
4— 525	G.E.	1	HJ-DD	2300x445
3— 333	Maloney	1	OISC	22000/11000x2300/575
2— 333	Whse.	1	OISC	2300x460
2— 333	Pitts.	1	OISC	2400x220
3— 300	G.E.	1	H	13200x2300/575
2— 200	G.E.	1	HILD	26400x115/460
3— 200	G.E.	1	H-KDD	13800x220/440
3— 150	Whse.	1	SK	2200x440/220
3— 150	Whse.	1	SKM	2400x120/240
6— 100	Whse.	1	SK	6900x460/230
3— 100	Whse.	1	OISC	13200x250

D. C. MOTORS

HP	Make	Type	Volts	Speed
2—1250	G.E.	MPC	500	130
1— 800	G.E.	MPC	550	600
2— 625	G.E.	MPC	250	130
2— 600	G.E.	MPC	550	600/800
1— 500	G.E.	MPC	230	900
1— 350	G.E.	MPC	230	450
2— 300	G.E.	DMC	230	400/600
2— 300	Whse.		500	250/400
1— 300	G.E.	MPC	230	275/550
1— 300	G.E.	MPC	230	250/440
1— 250	Al. Ch.	Irt	230	525
2— 200	Whse.		230	400/500
1— 175	Whse	SK	250	150/525
1— 150	G.E.	RC-19	230	800/1000
1— 150	Whse.	SK	230	300/900
2— 125	G.E.	CO-1832	230	625
2— 120	Whse.	SK	230	720
1— 100	Al. Ch.		230	950/1150
3— 100	G.E.	LC	230	1200
1— 100	G.E.	MPC	230	225/450
1— 100	Whse.	SK	230	600
2— 100	G.E.	RC-19	230	575/720
1 - 75	G.E.	C	230	500/1000
3— 70	Whse.	SK-183	230	560/780
1— 60	Al. Ch.	E-146	115	1150
1— 60	Al. Ch.	E-131	115	1750
1— 60	Diehl	K-11	230	500/1000
2— 60	Cr. Wh.	CMC-65H	230	500/1000
1— 50	Cr. Wh.	CMC-81H	230	300/900
1— 50	Cr. Wh.	CMC-80H	230	380/750
10— 50	G.E.	RF-16	230	400/1600

RE-NU-BILT BELYEA MOTORS

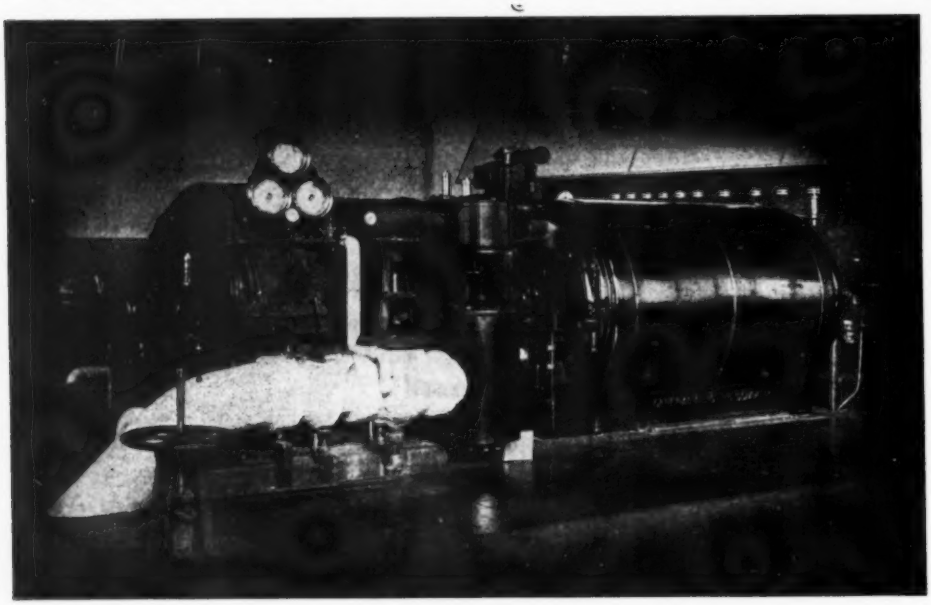
SUCCESSFUL OPERATION GUARANTEED

BELYEA

COMPANY INC.

***Main Office & Shop:* 43 HOWELL ST., JERSEY CITY, N. J.**

3125 KVA CONDENSING TURBINE-GENERATOR UNIT



ACTUAL PHOTOGRAPH

AVAILABLE IMMEDIATE DELIVERY

3125 KVA — 2500 KW 80% P.F. General Electric, 3 phase, 60 cycle, 2300 volt, 3600 RPM condensing turbine-generator unit, 180-200# I.S.P., 500° T.T., equipped with surface condenser, panels and instruments.

Excellent condition—a complete installation.

TURBINE-GENERATOR UNITS

3 phase, 60 cycle

1875 KVA G.E. condensing 175-200 lb. pressure, 500° T.T., 6600 volts, 3600 RPM complete with condenser.

937½ KVA G.E. automatic extraction condensing, 175 lb. pressure, 125°F. superheat, 15 lb. gauge, 2300 volts, 3600 RPM—complete.

625 KVA G.E. condensing 200 lb. pressure, 2300 volts, 3600 RPM complete with condenser and auxiliaries.

375 KVA G.E. condensing 150-200 lb. pressure, 100° SH, 2300 volts, 3600 RPM complete with surface condenser and auxiliaries.

375 KVA (2) G.E. non-condensing, 150-175 lb. pressure, 5 lb. back pressure, 2300 volts, 3600 RPM each complete with direct connected exciter.

125 KVA G.E. non-condensing, 110-125 lb. pressure, 0-10 lb. back pressure, 240 volts, 3600 RPM complete with switchboard.

ROTARY CONVERTERS

1500 KW Westinghouse synchronous 250 volts, direct current—6 phase, 60 cycle alternating current, 514 RPM

750 KW G.E. synchronous, 600 volts direct current, 6 phase, 60 cycle alternating current, 1200 RPM.

330 KW G.E. synchronous, 600 volt direct current, 6 phase 60 cycle alternating current, 1200 RPM with 2300 to 408 vol. transformers.

ENGINE-GENERATOR UNITS

Direct Current

1000 KW Westinghouse, 250 volts, 514 RPM generator direct connected through reduction gear to Westinghouse condensing turbine, 150-200 lb. pressure, equipped surface condenser.

600 KW Crocker-Wheeler, 250 volts, 300 RPM generator direct connected to a 14" x 18" 4 cylinder Ames vertical Unaflow non-condensing engine, 150-175 lb. pressure, 5 lb. back pressure, complete with switchboard.

400 KW G.E. 125 volts, 165 RPM generator direct connected to a 26" x 28" Elliott Ridgeway Unaflow non-condensing engine.

400 KW Crocker-Wheeler, 250 volts, 150 RPM generator direct connected to a 26" x 32" Skinner Unaflow non-condensing engine.

250 KW G.E., 250 volts, 150 RPM generator direct connected to a 20" x 28" Chuse non-releasing Corliss engine complete with switchboard.

150 KW General Electric, 240 volts, 200 RPM generator direct connected to Ames Unaflow non-condensing engine.

125 KW Elliott 125 volts, 250 RPM direct current generator, direct connected Elliott automatic engine.

75 KW 125 volt, 1800 RPM Westinghouse direct current non-condensing turbine-generator unit.

ENGINE-GENERATOR UNITS

3 phase, 60 cycle
Alternating Current

750 KVA G.E. 2300 volts, 150 RPM generator direct connected to Chuse 4-valve non-releasing cross compound Corliss engine, 150 lb. pressure.

625 KVA Allis (2), 440 volts, 150 RPM generator direct connected to a 26" x 30" Hamilton Corliss engine, 125-150 lb. pressure. 312 KVA G.E. 2300/480 or 240 volt, 200 RPM generator direct connected to a Chuse 4-valve non-releasing Corliss engine.

312 KVA Elliott 4000 2300/550 or 240 volts, 180 RPM generator direct connected to a 17" x 24" Elliott Unaflow non-condensing engine, 175 lb. pressure, 6 lb. back pressure.

250 KVA Westinghouse, 2300 or 480 volts, 200 RPM generator direct connected Nordberg Unaflow engine.

MOTORS

—3 phase, 60 cycle

900 HP G.E. 240 volts, 900 RPM synchronous.

500 HP 80% P.F., G.E., 240 volts, 900 RPM synchronous motor with direct connected exciter.

150 HP G.E. form K, 2200 volts, 580 RPM squirrel cage.

125 HP 80% P.F. Elec. Mchy, 440 volts, 400 RPM synchronous.

60 HP G.E. 220 volts, 900 RPM squirrel cage induction complete with starting compensator.

50 HP G.E. type I, form M, 2200 volts, 1200 RPM slip ring.

50 HP Allis-Chalmers, 440 volts, 600 RPM squirrel cage.

MOTOR GENERATOR SETS

1500 KW Allis-Chalmers, 600 or 275 volt direct current generator direct connected to 2190 HP, 3 phase, 60 cycle, 4000/6600 volt, 300 RPM synchronous motor.

SPECIALS

2000 KVA G.E. 3 phase, 60 cycle, 480 volt, 300 RPM alternating current generator.

528 HP Heine A.S.M.E. code water tube boiler 350# pressure, 635°F., complete with stoker, superheaters —a complete installation— modern and practically new.

500 KVA G.E. 3 phase, 60 cycle, 2300 volt, 450 RPM belted generator.

165 KW Electric Machinery, 3 phase, 60 cycle, 2400 volt, 514 RPM belted generator.

1—MODERN SLIGHTLY USED FAIRBANKS-MORSE FULL DIESEL UNIT CONSISTING OF:
350 HP, 5 cylinder, Model 32-D-14, vertical, 300 RPM engine direct connected to a 294 KVA, 3 phase, 60 cycle, 2400/550/440 or 240 volts alternating current generator. 22" x 48" Nordberg Corliss belted type engine, 150 to 175 lb. pressure, 100 RPM.

Utilities Electrical Machinery Corporation

600 NATIONAL CITY BANK BLDG.
CLEVELAND, OHIO

WIRE OR PHONE
LONG DISTANCE 422

ELECTRICAL POWER EQUIPMENT

TURBO GENERATORS

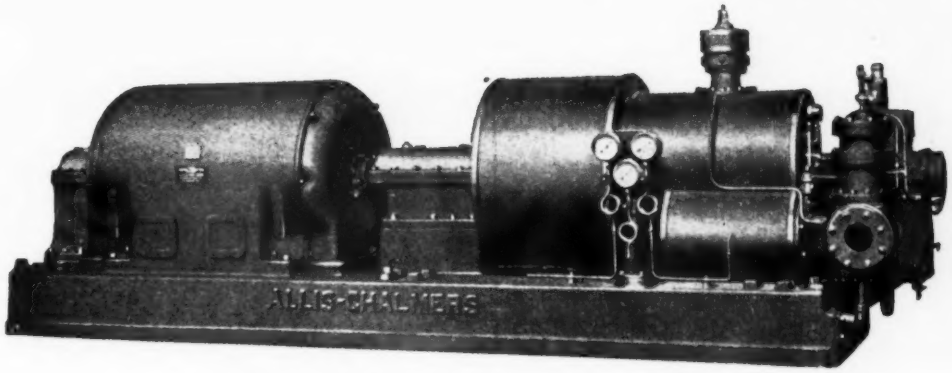
3 Phase, 60 Cycle

2500 KVA WESTINGHOUSE non-condensing, 250-400 lbs., 2300 volts.

1875 KVA GENERAL ELECTRIC 150-200 lbs. 2300 volts with surface condenser.

SURFACE CONDENSER

1540 sq. ft. WORTHINGTON surface condenser with steam jet air pumps.



1250 KVA ALLIS CHALMERS CONDENSING TURBO UNIT

1250 KVA Allis Chalmers alternating current generator 3 phase 60 cycle 2300 volts 3600 RPM direct connected to Allis Chalmers condensing turbine 150-200 lbs. steam pressure 100 deg. superheat. Equipped with jet condenser and auxiliaries.

ENGINE GENERATORS

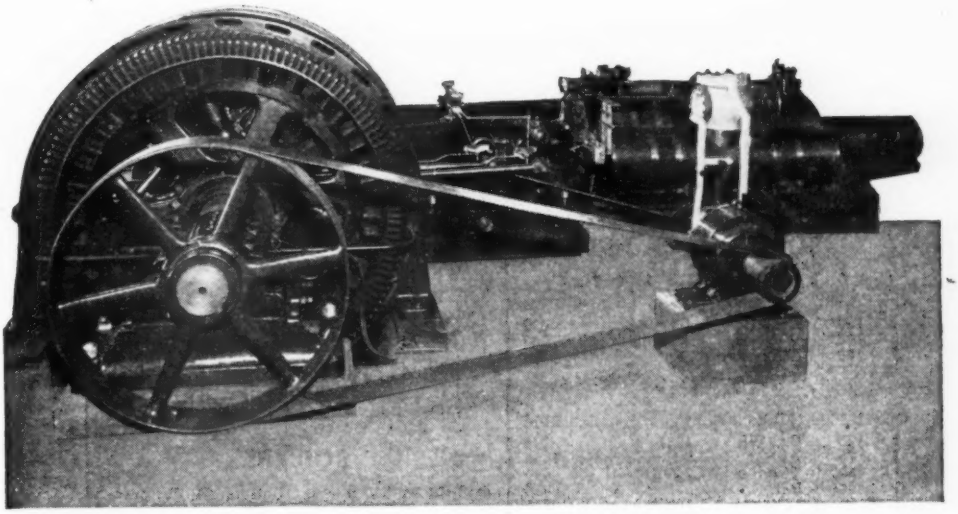
3 Phase, 60 Cycle

438 KVA GENERAL ELECTRIC-SKINNER uniflow, 150 lbs. 5 lbs. back pressure, 240/480/2300 volts, 150 RPM.

340 KVA WESTINGHOUSE SKINNER uniflow, 150 lbs., 5 lbs. back pressure, 240/480/2300 volts, 200 RPM.

210 KVA GENERAL ELECTRIC engine type generator, 2300 volts, 225 RPM.

150 KVA GENERAL ELECTRIC-AMES counterflow, 100-150 lbs., 5 lbs. back pressure, 240 volts, 257 RPM.



Actual Photograph

675 KVA SKINNER UNIFLOW UNIT

675 KVA Electric Machinery alternating current generator 3 phase 60 cycle 2300/600/480 volts direct connected to Skinner Universal uniflow engine, 150-175# steam pressure, 0-10# back pressure, 150 RPM.

MOTOR GENERATORS

3 Phase, 60 Cycle

1500 KW WESTINGHOUSE synchronous 275 volts D.C., 2200 volts A.C., 514 RPM.

1000 KW GENERAL ELECTRIC 3-UNIT synchronous 125/250 volts D.C., 4000/2300 volts A.C., 720 RPM.

ROTARY CONVERTERS

3 Phase, 60 Cycle

3500 KW (2) WESTINGHOUSE 225-285 volts D.C., 225 RPM, with 13200 volt transformers.

750 KW GENERAL ELECTRIC 600 volts D.C., 1200 RPM, with 2300/4000 volt transformers.

DIESEL GENERATORS

3 Phase, 60 Cycle

225 KVA WESTINGHOUSE-WORTHINGTON 2300 volts, 275 RPM.

DIESEL ENGINES

240 HP FAIRBANKS MORSE 6 cylinder model 35-E, 400 RPM

300 HP FAIRBANKS MORSE 4 cylinder model 32-E, 300 RPM.

THE NATIONAL POWER MACHINERY CO.
1921 SCRANTON ROAD — CLEVELAND, OHIO

ELECTRICAL and POWER EQUIPMENT

MOTORS

230 VOLT DIRECT CURRENT
CONSTANT SPEED

Qu.	H.P.	Make	Type	RPM
1	450	Al. Ch.	Int	425
1	125	G.E.	DLC	550
2	100	Al. Ch.	CPD INT	1000
1	100	Rel.	1050T	500
1	75	G.E.	DLC	525
2	50	West.	SK160	565
1	40	G.E.	RC15A	700
1	30	West.	SK120	975
2	30	G.E.	RC31B	1150
1	30	West.	SK140	600
3	25	West.	SK120	825
8	25	G.E.	RC31	1150
1	25	West.	SK	850
1	20	G.E.	RC11	1150
3	15	G.E.	RC10	1150
5	15	West.	SK 100 I	675
7	15	Rel.	92 T TE.BB	850
2	15	West.	SK90	850
4	15	G.E.	RC11	850
3	10	G.E.	RC29	1150
8	10	G.E.	RC29	850
3	10	West.	SK80	750
2	7½	G.E.	RC	1150
9	5	West.	SK40	850

VARIABLE SPEED

Qu.	H.P.	Make	Type	RPM
3	150	Diehl	K15	400/800
3	25/100	G.E.	MPC	300/600
1	110	West.	SA	650/1050
1	100	West.	SA	250/350
1	75	G.E.	LC	650/900
2	40	G.E.	LC	650/1300
3	30	West.	SK140	600/1200
1	25	West.	SK	400/1200
1	15	Wes.	SA9	300/1200
1	15	West.	SK103	400/1600
2	15	West.	SK	500/1500
2	10	Al. Ch.		500/1000

SQUIRREL CAGE

A.C. 3 PH. 60 CYCLE 2300 VOLT

Qu.	H.P.	Make	Type	RPM
1	150	G.E.	IK	900
2	100	West.	CS774C	900
1	100	G.E.	IK	514

220/440 VOLT

Qu.	H.P.	Make	Type	RPM
1	125	Cr. Wh.	125Q	900
1	75	Al. Ch.	Splash-proof	1200
1	50	Wagner	22VRM	600
1	40	Rel.		900
5	30	Wagner	19VRM	720
2	20	Rel.	120AA	900
1	20	Rel.	178AA	720
1	15	Gent.	SCN19	1200
3	3	Imp.	TE.BB	3600
5	1	Wagner	BB	1200

440 VOLT—3 PHASE 60 CYCLE

250 H.P. Gen. Elec., Type 1, Form K, 1760 RPM.
200 H.P. Allis Chalmers, 1750 RPM.
15 H.P. Gen. Elec., Type KT, 900 RPM with De Laval Worm Gear Reduction Unit 12¾ H.P. Ratio 13⅔ to 1.
15 H.P. Gen. Elec., Type KT, 900 RPM.
10 H.P. Gen. Elec., 1200 RPM.
10 H.P. Gen. Elec., Type KT, 1200 RPM.
7½ H.P. (Motor) Allis Chalmers, 1150 RPM.
5 H.P. Allis Chalmers, 860 RPM.
2—20 H.P. Allis Chalmers, 1740 RPM.
2—10 H.P. Gen. Elec., 1200 RPM.
2—25 H.P. Allis Chalmers, 860 RPM.
1½ H.P. Gen. Elec., 220/440 volt, 1720 RPM with G. & F. Speed reducer Worm Gear type ratio 10.20 to 1.
1½ H.P. Gen. Elec., 220/440, 1720 RPM.

TRANSFORMERS

60 CYCLE, SINGLE PHASE

3—333 KVA G.E. 2300/440/220 oil.
3—100 KVA Pittsburgh 2400/240/120 oil.
4—5 KVA Wsghse. 2300/230/460 air.
6—3 KVA G.E. 2300/230/115.

WATER WHEELS and GENERATORS

2—45" HERCULES Cylinder Gate Type B Water Wheels. Complete with Governors, pumps, and tanks. Each direct-connected to a WESTINGHOUSE ELECTRIC Vertical Generator 800 KVA, 3 ph., 600 V. 40 cy. 150 R.P.M.

750 KW GENERATOR

750 K.W. Ridgeway, 1800 R.P.M., 230 V., D.C. Compound, Interpole, two bearing. PRACTICALLY NEW.

230 VOLT DIRECT CURRENT

100 KW Ft. Wayne MPL 550 RPM.
100 KW G.E. MPL 600 RPM.
200 KW Sprague 525 RPM.
200 KW West. 500 RPM.
250 KW West. 500 RPM.

MOTOR GENERATOR SETS

75 H.P. Westinghouse 440, 60, 3, 840, direct connected to Westinghouse.
50 KW Generator, 125 V.
1—35 KW GENERAL ELECTRIC Motor Generator Set, 125 Volt D.C., 1200 R.P.M., R.C. Generator; Motor General Electric KT, 550 Volt, with compensator and D.C. Panel.

BOILERS

4—1010 H.P. Watertube boilers, 250 lb. pres., steel headers, long drums. ASME Code—complete with oil burning equip., pumps, Foster superheaters and accessories.
2—316 H.P. Heine Watertube boilers, 160 lb. pres., hand fired.
2—684 H.P. Edgemoor Waste Heat Boilers, 200 lbs. pres., complete with Economizers, Super Heaters, motor driven blowers and steel stacks.
2—500 H.P. Edgemoor, 200 lbs. pres., ASME Code, with Riley side dump stokers.

PULVERIZER

1—Jeffrey Swing Hammer Pulverizer 30"x 24", type A, complete with 75 H.P. Allis Chalmers Motor and Compensator.

STOKER

1—Jones, 3 retort, steam actuated, underfeed, ram stoker.

CONDENSER

1—C. H. Wheeler 3650 Sq. Ft. Surface Cond. 2 pass. complete with pumps.

TURBO-CENTRIFUGAL PUMP

Terry Steam driven Turbine centrifugal pump, type GF, turbine 710 H.P., 145 lb. steam pressure, 60 lb. back-pressure, 3581 RPM direct connected to Gear Unit 1000 RPM; type U Allis Chalmers Centrifugal Pump 18"x18", 13,000 GPM at 170' head, 1000 RPM. Pump or turbine may be bought separately.

CENTRIFUGAL PUMPS

2—Lecourtenay 5" all bronze centrifugal pumps 500 GPM at 90' head direct connected to Allis Chalmers 20 H.P. Motor 440, 60, 3, 1740 RPM.
2—Lecourtenay 12" Iron Casing Motor Driven Centrifugal Pumps, type 12BT8, 5,000 GPM at 148' H., Direct connected to G.E. 250 H.P. Motor, type 1, E15 form K, 440, 60, 3, 1760 RPM.
Lecourtenay 12" Iron Casing Motor Driven Centrifugal Pump, 4,500 GPM at 135' H. 1750 RPM Direct Connected to Allis Chalmers 200 H.P. Motor 440, 60, 3, 1750 RPM.
8—Gould Centrifugal Pumps 270 GPM, 30' M. Direct Driven by 5 H.P. A.C. Motor.
Cameron Centrifugal Purchased New 1923. Bronze fitted, mounted on common subbase for motor drive—
1—Size 14—700 RPM 4700 GPM 35' head 60 H.P.
1—Size 14—720 RPM 5500 GPM 30' head 75 H.P.
1—Size 16—350—RPM 3500 GPM 45' head 125 H.P.
All Pumps Tested Hydrostatically for 125 lbs.
All Double Suction Volute, Gate Valves Attached.
1—Davidson 14x9¼x16 Simplex Double acting piston pattern, brass fitted.
1—Gould Triplex Pump 5x8.

STEEL TANK

350,000 gal. Steel Water Storage Tank 40' high, 40' dia.

FEEDWATER HEATER

1—Cochrane Feedwater Heater 5000 H.P., open type.

OVERHEAD CRANE

1—15 Ton, OVERHEAD CRANE, 50 ft. span overhead Travelling Crane, Electric lift, hand travel.
1—25 Ton OVERHEAD CRANE, Hand Operated.

SPEED REDUCERS

G. & F. Speed reducer, Worm Gear type, ratio 10.20 to 1.
De Laval Worm Gear Reduction Unit 12¾ H.P. Ratio 13⅔ to 1.

HEAT and POWER Company

45 BOND STREET **Phone: Algonquin 4-3874** **NEW YORK 12, N. Y.**

KIEMLE OF TOLEDO, OHIO

MOTORS
GENERATORS
CONTROLS
TRANSFORMERS
MOTOR GENERATOR SETS
ETC.

BERGER OF ROCHESTER, N.Y.

Put all idle equipment to work. Send your list for prompt action.

TRANSFORMERS

3—500 KVA, GE, type H, form VD525 19100-22000/40000Y to 2300, 1 phase 25 cycle.
1—200 KVA Maloney type H.E. 2400/120/240 volts, 1 phase 60 cycle.
1—200 KVA, G.E., type H.K. 2300/115/230 volts, 1 PH. 60 cy.
2—250 KVA Pittsburgh, 2300/115/230 volts, 1 PH. 60 cy.
2—75 KVA West. type S.K. 1 ph. 25 cy. 60000 volts Prim—6900/2300 volts secondary.

OTHER SIZES, VOLTAGE AND CYCLES AVAILABLE

ALTERNATORS

240 KW, 8 PF Electric Machinery, 4600 volts, 60 cycle 3 phase, 450 rpm with direct connected exciter.
200 KW Westh. Unity Power Factor, 3 PH. 60 cyc. 900 R.P.M. with direct connected exciter.
150 KVA Gen. Elec. Type ATB form D, 60, 3 ph., 220/440 600 RPM, revolving field, built-in exciter.
150 K.W. Elect. Mach. Revolving fields 3 Ph. 25 cy. 440 volts 750 R.P.M.
90 K.W. Gen. Elect. Rev. field type A.T.B. .8 P. F. 3 Ph. 60 Cy. 240 Volts 900 RPM.

D. C. GENERATORS

150 KW Western Elec. 3 brg. 3 wire, 115/230 V, 600 RPM.

MOTOR GENERATOR SETS

Western Elect. 1000 Amps — 40 volts direct con. to either AC or DC 580 RPM Motor.
125 K.W. Crocker Wheeler, 250 Volts D.C. Comp. WD. Dir. Con. To G.E. 2300 or 440 Volts Sq. Cage Motor
100 K.W. Gen. Elect. 3 BRG. 125 Volts D.C. Comp. WD. INT. with 220/440 Volts Sq. Cg. Motor.
100 K.W. Gen. Elect. 3 BRG. 230 Volts D.C. Comp. WD. INT. with 2300 Volts Sq. Cg. Motor.

CRANE MOTORS

75 H.P.—G. E. 51—230 Volts—550 RPM
35 H.P.—G. E. Form D—550 Volts—590 RPM
25 H.P.—Form E—550 Volts—760 RPM

2-Ton Shephard Hoist With 3-H.P. Hoist Motor and 2-H.P. Trolley Motor 3 Phase. Can Be Used Remote Control.

300 KW Gen. Elect. Synchronous Converter, 6 Phase, type HCC form J, 25 cycle 750 speed 230 volts. With Transformers for 2300 volts.

FREQUENCY CHANGERS

40 KW GE type I.T.T. frame 553 3 ph. 25/62, ½ cy. 220 volts primary 440 volts secondary, 750 RPM direct con. to 40 H.P. GE type KT543— 3 ph. 25 cy. 220 volt, 750 RPM.

OTHERS IN ALL SIZES VOLTAGES AND CYCLES

3 ph. 60 cy. A. C. MOTORS

H.P.	Make		Type	Speed	Volts
250	West	S.C.	C.S.	900	440
200	West	Syn.	.08 P. P.	900	220/440
		WITH DIRECT CON. EXCITER			
200	Wsghse.	Sl. Rg.	CW	600	220/440
200	Gen. Elec.	Sq. Cg.	1 Form K	514	220/440
200	Gen. Elec.	Syn.	ATi	514	4000/2300
175	Ideal	Sl. Rg.	AVA	1750	2200
150	Gen. Elec.	Sq. Cg.	I	600	2300
150	Al Ch	Sq. Cg.		600	440
150	Burke	Sq. Cg.	3 BRG. 2 ph	900	220/440
125	Gen. Elec.	Sl. Rg.	NT. 553	1200	220
125	Gen. Elec.	Sq. Cg.	I K	720	220/440
25	Gen. Elec.	Sq. Cg.	I. K. Vert.	720	220

3 ph. 25 cy. MOTORS

H.P.	Make		Type	Speed	Volts
830	Elect. Mach.	Syn.	Dir. Con. Exc.	500	2300
350	Gen. Elec.	Sl. Rg. 3 Brg.	I	375	440
200	Lincoln	S. R.	I. X. W.	500	440
150	Burke	Syn.	Dir. Con. Exc.	500	440
150	Gen. Elec.	Sl. Rg.	I Form M	500	2200
100	Wagner	Sl. Rg.	BR	750	220/440
100	Gen. Elec.	Sl. Rg.	I Form M	750	220/400
100	Gen. Elec.	Sq. C.	I K	750	220/440
100	Wsghse.	Sq. C.	CS	500	220/440
75	Wsghse.	Sq. C.	CCL	500	220/440
75	Gen. Elec.	Sl. Rg.	I M	750	220/440
75	Wagner	Sq. C.	BM	750	2200
75	Gen. Elec.	Var.	BTA	375/750	440
50	Burke	Syn.	AC 133	750	220
		WITH DIRECT CON. EXCITER			

230V D. C. MOTORS

H.P.	Make	Type	Speed
150	West	SK 180L Comp. Wd. Int.	1150
125	G.E.	CL	850
100	Northwestern	K30 Comp. Inter.	1750
85	Gen. Elec.	Vert. Comp. Wound	700
75	Crocker Wh.	CCM25JA	1700
67	Otis	Elevator Motor Comp. wd.	1200
60	Sprague	D—Comp. Wound	625
50	Gen. Elec.	C. L. 6 Shunt Wound	560
40	Fair. Morse	Ball BRG. Vert. Comp.	1740
32	Sturdevant	C Form P. Shunt Wound	190

Only partial listing

OVER 10,000 ITEMS IN STOCK FOR IMMEDIATE DELIVERY FROM EITHER ROCHESTER, N. Y. OR TOLEDO, OHIO REBUILT AND SOLD WITH A STANDARD NEW GUARANTEE.

Write or wire your inquiries

BERGER BROTHERS
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395 STATE ST.
ROCHESTER NEW YORK

The Mark of Dependability

THE FRED W.
KIEMLE CO.
33 N. SUPERIOR ST.
TOLEDO OHIO

1904—40 Years Continuous Service to Industry—1944

RELY ON US—FOR GOOD EQUIPMENT

WRITE • PARTIAL LIST ONLY • WIRE

DIRECT CURRENT MOTORS

115 Volts

H.P.	Mfr.	Type	Speed
40	G.E.	RC 32	1150
20	Whse.	SK-120	650
20	L. Allis	WD-20 (Vert.)	1000
15 B. Brg.	Cr. Wh.	CCM	850
10	Whse.	SK-60	1150
10	Whse.	SK	850
7½	G.E.	RC	1750
¾ (6)		BD Vertical	3450

Many other smaller motors, too numerous to list.

DIRECT CURRENT MOTORS

230 Volts

H.P.	Mfgr.	Type	Speed
75 (2)	Reliance	310T	1450
65	Cr. Wh.	CMC 65H	600
61/70 (3)	G.E.	CDM	352/400
50	Cr. Wh.	CMC	700
35	G.E.	RF	500/1500
30	Reliance	131T	1450
30	Imp.		850
30/35	G.E.	CDM	176/200
25	G.E.	DLC	750
25	G.E.	CVC	1200
20	Reliance	92T	1450
20	Whse.	SK-111	720
20	Burke	WA-4	900
20	G.E.	CD-105	600
20	G.E.	CQ	1700
20	Whse.	SK-100L	900
20	Whse.	SK	1700
20	Al. Ch.	E-100	1150
20 (2)	G.E.	RC27B	3450
20	Triumph	24F	1750
20	G.E.	RC-11	1150
20	Elec. Dyn.		950
20	Louis Allis		850/1700
15	West.	SK-601	1700
15	Roth	7-8	1150
15 (2)	G.E.	RC-30	850
15 (10)	Reliance	Ball bearing	850
15	Elec. Dyn.		600
15	Whse.	SK-80	1100
15	G.E.	RC-31	1100
15	Cr. Wh.	CM	1150
15	G.E.	RC-30	850
15	Imp.	HV-1	850
15	Imperial		575
12½	West.	SK	400/1400
10	Whse.	SK-63	1150
10 (2)	G.E.	LC	1000/1500
10	W. Elec.	ER3A	1000
10	G.E.	RC-29	850
10	Cr. Wh.	CM	850
10	Whse.	SK-70	850
10	Whse.	SK-90	600
10	G.E.	RC-49	850
10 (2)	G.E.	CVC-115	700
7½	G.E.	RC	3450
½ (16)	G.E.	BD Vert.	3450

The above listing is a very small part of the items in stock.

DIRECT CURRENT GENERATORS

KW	RPM	Volts	Make
115	600	250	Cr. Wh.
100	1000	125	G.E.
100	900	125	Whse.
75	1750	250	Reliance
65	720	250	Cr. Wh.
30	1750	250	Reliance
25	490	125	G.E.
20	1750	250	Reliance
20	900	125	Whse.
15 (2)	1140	250	Reliance
15	1140	125	G.E.
10	1140	250	G.E.
10	1750	125	Whse.
6	900	125	Whse.

Also a large assortment of special voltages. We specialize in building Motor Generator Sets to your specifications.

MOTOR GENERATOR SETS

KW	Make	D.C. Volts	Drive
50	G.E.	125	3/60/2300
25	G.E.	125	3/60/440
35	Burke	125	3/60/220
25	Burke	125	3/60/550
15	G.E.	125	3/60/440
6 (2)	G.E.	75	3/60/220
3	Roth	125	3/60/220
3	Chand.	6–12	3/60/220
2	Cont.	120	3/60/220

D.C. STEAM DRIVEN GENERATORS

1—300 K.W. 250 v. Skinner Uniflow

1—200 K.W. 125 v. Skinner Uniflow

EXTRA SPECIAL

NEW! NEW! NEW!

1 KW and 5 KW single phase 110 v. 1800 R.P.M., 60 cy. Generators.

DIRECT CURRENT CRANE AND MILL MOTORS

Mfr.	Type	Speed	Volts
G.E. (2)	CO 1832	600	230
G.E. (2)	CO 1811	600	230
G.E. (2)	CO 1809	550	115
G.E.	CO 1807	800	230
G.E.	CO 1808	600	550
G.E.	CO 1806	875	230
G.E.	CO 1806	575	115
G.E. (2)	CO 1803	600	230
Whse.	K-10	525	230
West. (6)	K1	950	230
West. (6)	K1	950	550
West.	HK3	800	230
West.	HK2	850	230
Whse. (5)	HK-5	700	230
West.	CK-9	335	230
North.	K-T 35 H.P.	800	230
P & H	12x8	430	230

The above items are constantly changing. Suggest you let us know your needs, if the item you want is not listed.

SYNCHRONOUS MOTORS

3 Phase 60 Cycle

H.P.	Mfr.	Volts	Type	Speed
350	Electric Machinery	2300		900
250	Whse.	440		1200
250	G.E.	440	ATI-PB	720
187½	Whse.	220		600
175	G.E.	220	ATI-PB	514
175	West.	440		900
125	Cr. Wh.	220		900
100	Whse.	440/220		900

AC GENERATORS

3 Phase 60 Cycle

KVA	Mfr.	Volts	Type	Speed
300	G.E.	600	ATB-PB	600
225	G.E.	480	ATB-PB	720
225	Whse.	440/22	Pedestal	200
225	West.	2300		600
200	Lincoln	220		720
187½	Whse.	240	Pedestal	600
150	G.E.	240	ATB	514
150	Al. Ch.	440		900
100	Cr. Wh.	240		900
100	West.	240		900
7½	G.E.	220	AS	1800

SLIP RING MOTORS

3 Phase 60 Cycle

H.P.	Mfr.	Type	Volts	Speed
600	Whse.	CW	2200/550/440	590
400	G.E.	IM	2200/550/440	720
250	G.E.	IM	440	514
200	Cr. Wh.		2200	600
200	Whse.	CW	200	1150
150	G.E.	IM	2200	600
150	G.E.	IM	550	600
100	Whse.	CW	440	600
75 (3)	G.E.	MT	440/220	1200
75 (2)	Cr. Wh.	SR	440/220	1200
75	Whse.	CW-746	440/220	1200
52	G.E.	ITC5012	440	900
50	G.E.	IM	440	900
50	Cr. Wh.		440	900
50 (2)	G.E.	MT	440/220	900
50	G.E.	I-M	440	1200
50	G.E.	MT-556Y	220	600
40	Al. Ch.		440	900
40	G.E.	MT	220	1200
40	Whse.	CW	2200	1750
40	Whse.	CW-636A	220	1160
40	G.E.	MT	550	900
40 (2)	Whse.	CW	550	900
37	G.E.	ITC5012	220	600
35	Ridgway		2200	600
35	G.E.	IM	2200	1200
35	G.E.	IM	2200	900
35 (2)	G.E.	IM	220	720
30	Fks. M.		220	1200
30	G.E.	MT-332	220	900
30 (2)	G.E.	MT-336	220	900
30	G.E.	MT-342	220	720
27	G.E.	IM	440	600
25	Al. Ch.		550	1800
25	G.E.	MT-536	550	720
25	Diehl	KK14R	220	850
20	Fks. M.		220	1200
15 (2)	G.E.	IM	220	1200
15	Al. Ch.	ARY	550	1200
15 (2)	G.E.	IM	220	900
15	G.E.	MT 312	220	900

2—1750 K.W. G.E. 6 ph. 250 v. D.C. 514 R.P.M. Synchronous Converters.

1—1150 K.W. as above. 720 R.P.M.

SQUIRREL CAGE

3 Phase 25 Cycle

H.P.	Mfr.	Type	Volts	Speed
125	Whse.	CS	440	720
100 (2)	G.E.	IK	440	500
75	Whse.	CCL	550	480
40 (3)	Al. Ch.		550	3400
30	Whse.	CS	440/220	720
35	West.	MS	440	720
25	G.E.	IK	440	720
25	Ideal	A	440	720
25	West.	CS	440	720
20	G.E.	IK	220	720
20	West.	CCL	220	1500
20	Wagner		440	1500
20	West.	CS	440	600
20	G.E.	IK	440	1500
17½	Lincoln		220	1500
15	Whse.	CCL	440	500
15	Wagner	17TBP	440/220	1500
15	Ideal	A	440	1500
*15	Cent.	RS 308	220/110	1500
15	Ideal	AVE	440	720
15 (2)	Burke		440	1500
10	G.E.	IK	220	500
*10	G.E.	KT 958	440/220	1500
10	Whse.	CCL	220	1500
10	Whse.	CS	440/220	750
10	Ideal	A-80	440	750
10 (2)	Whse.	CS-567	440/220	750
10	Whse.	CS	440/220	500
5 (2)	G.E.	KT	440	1500
5 (3)	West.	CS	440	1500

*Single Phase.

SPECIAL! SPECIAL!

A.C. GENERATORS

31½ KVA, 25 KW, 120/208 V., 1200 RPM. Ball bearing with direct connected exciters and rheostats. Adaptable for direct connection to diesel, gasoline or electric motor drive.

18 Hercules Diesel Engines Type D J X D 103 H.P. 2600 R.P.M. Electric Starters, generators and radiators.

SLIP RING

3 Phase 25 Cycle

H.P.	Mfr.	Type	Volts	Speed
150 (2)	G.E.	IM	440	500
150	Triumph	3-bearing	2200	720
100	G.E.	IM	440	750
25	G.E.	MTC 5323	440	750
15	G.E.	MTC-Hoist Duty	440	675
15	Whse.	HF	440	710
10	G.E.	MT 323	220	750
10	G.E.	MT 523	220	750

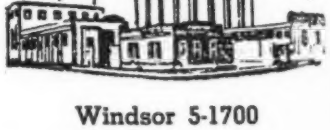
SQUIRREL CAGE MOTORS

60 Cycle 3 Phase

H.P.	Mfr.	Type	Volts	Speed
225	G.E.	IK	2200	720
225 (3)	Whse.	CS	440	900
200	C.W.	IK	440	900
200	G.E.	IK	440	900
200	Burke	EM50	440	600
200	G.E.	IK	440	600
200	G.E.	IK	2200	514
200	Cr. Wh.		440	720
150 (2)	G.E.	IK	440	720
150	Al. Ch.		2200	1800
150	Al. Ch.		440	1800
150	Cr. Wh.		2200	600
150	Burke	EM309	440	720
150	Al. Ch.		440	600
125	G.E.	IK	440	720
125	Cr. Wh.		2200	600
100	G.E.	IK	550	720
100	G.E.	IK	550	600
100 (4)	G.E.	I-L	550	720
100	G.E.	IK	550	900
100	G.E.	KT	550	900
100*	G.E.	KT346	440	1200
100	West.	CS	440	720
75	G.E.	I-L	440	360
75	G.E.	I-L	440	514
75	Al. Ch.		220	720
75	G.E.	I-K	440	720
75	G.E.	I-L	550	720
75 (2)	West.	CS	440	900
75	G.E.	Vert.	440	1200
60	Al. Ch.	Sp. pr.	2300	1800
60 (2)	G.E.	IK	440 220	1200
60	F.M.	H	440	900
50	Al. Ch.		2300	900
50	Ridgway		2300	600
50	West.	CS	440	900
50 (2)	West.	CS	220	720
50	G.E.	KT552	440	720
40	G.E.	K	550	900
40 (2)	Al. Ch.		440	900
40	G.E.	I-L	440/220	900
40	Cr. Wh.		220	200
40	F. M.	H	220 440	900
40	Al Ch		440	200
40 (3)	Al Ch	B. B.	550	450

ALL EQUIPMENT GUARANTEED FOR ONE YEAR

★ WANTED TO BUY: Stationary Air Compressors, Belt or Steam Driven



Benjamin's for Motors

ESTABLISHED 1904

Windsor 5-1700

12th AVENUE AND 37th STREET ★ BROOKLYN, 18, N. Y.

REBUILT POWER EQUIPMENT

READY TO SHIP!

AIR COMPRESSORS

1—599 CFM Ing. Rand Imperial 10, XB-2 horiz. 2 st. duplex, 100 lbs. pres. with A.C. mtr.
1—725 CFM Nat'l Brake, type 3VD, 100 lbs. pres., single stage, complete with A.C. mtr.
1—888 CFM Ing. Rand Imperial 10, XB-2 horiz. 2 st. duplex, 100 lbs. pres. with A.C. mtr.

MOTOR GENERATOR SETS

1200 kw. G.E. 275 v. 720 rpm., 4100 v., 3 ph. 60 cy. syn.
1000 kw. G.E. 250 v. 720 rpm., 4150 v. 3 ph. 60 cy. syn.
1—150 KW Ridgway 250 v. 900 rpm. 2200 v. 3 ph. 60 cy. syn.
1—150 kw. Crocker Wheeler 250 v. DC, 600 rpm. dir. con. to 220/440 or 2200 v. syn. motor.
100 kw. West. 3 wire 250/125 v. 3 unit M.G. Set 327 rpm., 2200/220/440 3 ph. 60 cy. Syn.

100 HP. LIDGERWOOD HOIST

Double drum Speedwell 2500 lb. pull at 450' per min. direct driven by 100 hp. A.C. or D.C. Motor.

A.C. GENERATORS

1—62½ KW Westg. 2300 v. or 220/440 3 ph. 60 cy. 1200 rpm.
1—125 KVA Westg. 2200 v. 3 ph. 60 cy. 327 rpm
1—150 KVA Wagner 220/440 v. 3 ph. 60 cy. 600 rpm.

TACHOMETERS

3—Brand New, Model C Hickok Generators, 0/2000 rpm., flexible couplings, Hickok model meters—2000 rpm.

SCALES

9—Howe Scales—3 beams (2 at 200 lb. ea.—1 at 50 lbs.). Platform 14¼x22". Approx. capacity 500 lbs.

25 CY. MOTORS—220/440 V. A.C.

HP	Make	Type		RPM
150	G.E.	I-K	2200	1500
150	G.E.	I-K	6600	1500
100	G.E.	I-K	2300/4000	750
52	G.E.	ITC		750
40	Al. Chal.	AN		750
35	G.E.	I-M		500
30	Al. Ch.	AN		750
25	Westg.			750
7½	Westg.			705
3	G.E. (1 ph.)	SCR		1500
1	Westg. (vert.)	CSA		750

SLIPRING MOTORS—3 PH., 60 CY.

HP	Make	Type	Volts	RPM
350	Westg.	CW	2200	900
260	Burke	EMV-65	220/440	600
250	Westg.	CW	2200	345
150	G.E.	I-M	220/440	720
150	G.E.	MT	2200	1200
100	G.E.	IM	220/440	900
100	G.E.	IM	2200	450
100	Westg.	CI	220/440	1750
75	Westg.	CW	220/440	690
75	G.E.	I	220/440	900
75	G.E.	ITC	220/440	1800
62	Westg.	CW	220/440	1135
60	Triumph	C-16	220/440	430
52	G.E.	ITC	220/440	900
50	Al. Chal.		220/440	490
50	Westg.	HF	220/440	860
50	G.E.	enc.	220/440	1200
50	Westg.	CW	220/440	1150
50	Chandeysson		220/440	1800
40	G.E.	MT	220/440	720
40	G.E.	MT	220/440	1200
20	Cr. Wh.		220/440	850
15	G.E.	IM	220/440	850

A.C. MOTORS—3 PH., 60 CY.

HP	Make	Volts	RPM	Type
1000	G.E.	2300	509	K
250	G.E.	220	720	IK
209	G.E.	220	514	IK
200	Westg.	220/400	580	CS
200	G.E.	220/440	720	IK
150	Westg.	2200/440/220	327	syn.
150	G.E.	220	450	IK
150	G.E.	440	514	IK
150	G.E.	550	575	IK
150	G.E	220	575	
150	G.E	440	600	IK
125	Cr. Wh.	220	720	
125	G.E.	220	400	IK
125	G.E	440	450	IK
125	G.E.	440	514	IK
125	Al. Ch.	220	800	
100	G.E	440	400	IK
100	Cr. Wh.	220/400	575	
100	Westg.	220/440	700	CS
100	G.E.	550	900	IK
100	Westg.	220	1750	
75	Cr. Wh.	220	514	
75	Westg.	220	600	CS
75	G.E	550	720	IK
75	Cr. Wh	550	900	
75	G.E.	220/440	1150	
75	Westg.	2200/220/440	1200	
75	Al. Ch.	220/440	1800	AN
65	G.E.	220/440	1200	IK
65	Al. Chal.	220/440	1800	AN
75	Louis Allis	220/440	170/1770	
60	Triumph	220/440	430	
60	G.E.	550	600	IK
60	Cr. Wh.	220	670	
60	Westg.	220	720	CS
60	Al. Ch.	440	1200	AN
60	Al. Ch.	220/440	1800	AN
54	Al. Ch.	220/440	900	
50/32	G.E.	220/440	800/640	POS
50/100	West.	220/440	345/700	CS
50	G.E.	220/440	400	IK
50	G.E.	220/440	450	IK
50	Westg.	220/440	514	CS
50	Westg.	220/440	600	
50	Westg.	220/440	690	
50	Westg.	220	720	CS
50	Westg	220/440	850	
50	Amer. (vert.)	440	900	
50	Reliance	220/440	1200	
50	G.E.	220/440	1200	IK
50	Al. Cha	220/440	1800	AN
40	G.E.	220/440	360	IK
40	Westg. (totally enc.)	220	600	CS
40	Amer. (vert.) (fan cooled, totally enc.)	220/440	685	
40	Amer. (enc. ball bearing)	220/440	685	PK
40	Reliance	220/440	900	
35	Westg.	220/440	514	CS
35	Lincoln	220/440	720	
35	G.E.	220/440	900	
35	G.E.	220/440	1200	IK
35 (new)	Westg.	220/440	1800	CS
30	Amer.	220/440	600	
30	G.E.	220	900	I
30	Triumph	220	1200	
25	Triumph	220	850	
25	Westg.	220/440	1200	CS
1½	Ilg.	220	490	
½	G.E.	220	1200	
½	G.E.	220	900	K

VARIABLE SPEED MOTORS—230 V. D.C.

HP	Make	Type	RPM
250	Cr. Wh.	CMC	200/400
75	Westg.	SK-181	400/800
35	Westg.	SK-140	675/1350
30	G.E.	RLC	450/900
20	Westg.	SK-110L	750/1500
20	Westg.	SK-100L	900/1800
15	Louis Allis		1150/1750
15	Westg.	SK-90	850/1700
10	Westg.	SK-111	300/1200
10	Westg.	SK-70	850/1700
10	G.E.	LC	625/1250
10	Westg.		565/1130
7½	Westg.	SK-111	200/1200
7½	Cr. Wh.		385/1155
5	Reliance	F-21	300/1800
3.75	Westg.	SK-111	300/1200
3¼	Westg.		400/1600
3	Jantz-Liest		650/1950
2½	G.E.	RLC	500/1000

TRANSFORMERS—1 ph. 60 cy.

No.	Kva.	Pri.	Sec.	Make	Ph.
1	250	2300	460	G.E.	
1	100	2200	110/220	G.E.	
3	100	6600	550/440/220	Pgh.	
2	75	2200	200	Burke	ph.
2	50	2300	220/440	G.E.	
3	50	11430/6600	550	Al. Ch.	
3	50	6600	575	G.E	
1	37½	2300	220/440	Wagner	
3	37	4400	185	West. (Rotary)	
1	30	2200	110/220	G.E.	
40	10	2200	110/220	West.	
100	7½	2200	110/220	G.E.	
50	5	2200	110/220	G.E.	
75	5	2200	110/220	West.	

INDUSTRIAL TRUCKS

1—Baker Tow Truck with batteries.

PUMPS

2—#7 Blackmer Rotary Pumps 24' hd. 25 gpm.
2—New Movno Pumps 2x2, 40 gpm., 100' hd.
2—New Wilfrey 2x1½—50 gpm.
1—100 gpm. American 5 hp. motor Portable
1—2500 gpm. Allis Chal. 95/125' hd.

SPEED REDUCERS

.55 Link Belt ratio 342:1
3 HP. Boston ratio 900:1
3 HP. Link Belt triple reduction herringbone ratio 221:1
3 HP. Farrel double reduction ratio 19:1
5 HP. Boston ratio 32:1
5 HP. Link ratio 17:1
7½ HP. Boston ratio 32:1
10 HP. Link Belt 17:1
10 HP. Boston ratio 32:1
300 HP. Nuttal ratio 1.6:1

CHAIN BLOCKS—with or without trolleys

2—Chisholm Chain Blocks 2 tons
2—Ford Triblock—2 ton
4—Ford Triblock—3 ton
1—Phila.—3 ton

RAILROAD CAR PULLER

With 5 HP., 230 v. D.C. motor, triple reduction, 40' per min. with rev. controller will coil 250' of cable

Large Stock—CIRCUIT BREAKERS—METERS — CURRENT AND POTENTIAL TRANSFORMERS—POTHEADS—RELAYS—METERS — SAFETY SWITCHES — DISCONNECT SWITCHES — U-RE-LITES — PULLEYS — REACTORS.

WRITE, WIRE OR PHONE YOUR ELECTRICAL REQUIREMENTS—SEND FOR STOCK LIST.

LIST YOUR IDLE EQUIPMENT WITH US.

DUQUESNE ELECTRIC & MFG. CO.

PITTSBURGH 6, PA.

BOILERS

1—528 HP **Heine**, 350 lb. with underfeed-stoker.
1—335 HP **B & W Sectional Header Boilers,** 200# pressure with superheaters, hand fired grates.
1—250 HP **Casey-Hedges,** 160 lb. pressure.
1—400 HP **Wickes** 3 drum low head boiler, 200# pressure with Chicago Spreader stoker. Installed 1932.
1—90,000# per hr. **Badenhausen Boiler,** 354# pressure.
1—357 HP **HEINE** with Riley Underfeed **Stoker.**
2—600 HP **B & W** sectional header boilers. 200# pressure.
2—300 HP **Heine** 175# pressure.
2—250 HP **Wickes vertical boilers,** powdered fuel.
6—600 HP 200# pressure **O'Brien** boilers.
1—394 HP **Sterling Boiler** chain grate stoker, 160# pressure.
1—585 HP **Erie City** vertical boiler 185# pressure, Type E stoker.
2—253 HP **Sterling Boilers,** 160# pressure with oil burners.
1—444 HP **Union Iron Works Boiler,** 225# pressure.
2—500 HP **Edge Moor Boilers** 200# pressure.
1—600 HP **Union Iron Wks,** 250# **pressure boiler,** chain grate stoker. New 1935.
1—440 HP **B & W Sectional Head Boiler** 150# pressure, underfeed stoker.
1—522 HP **Sterling Boiler** 200# pressure with **Firite Stoker.**
2—600 HP **Stirling Boilers** 200 lb. pressure.
1—484 HP **Springfield Boiler,** 250# pressure oil **burners.**
2—309 HP **Heine** Marine boilers 225# pressure.
2—350 HP **Stirling** boilers with auxiliaries.
1—250 HP **Heine boiler,** underfeed stoker.
8—150 HP **HRT Boilers,** 150# pressure.
4—750 HP **Bigelow Hornsby** 225# pressure with pulverizers.
4—1010 HP **Heine** watertube boilers 250# pressure.
1—400 HP **Connolly Boiler** 160# pressure with new tubes and auxiliaries.
4—72" x 18' **HRT** boilers including a 637 KVA General Electric condensing turbine. Complete plant.
1—150 HP **HRT.** 125# pressure, rebuilt and guaranteed.
56—50 HP **Vertical Boilers** 150# pressure all auxiliaries.

TURBINES

2—5000 KW **Westinghouse** 1800 RPM 3-60-2300 volts **Surface Condenser** all auxiliaries.
1—3200 KW **Allis-Chalmers Condensing Turbine** with auxiliaries.
1—2500 KW **General Electric Condensing Turbine** with auxiliaries.
15,000 KVA **Westinghouse** turbine, condenser.
1—1000 KW **Westinghouse non-condensing turbines** 350# pressure, 16# back pres.
1—937 KVA **Allis-Chalmers Turbine.**
1—625 KVA **General Electric Turbine** with jet condenser.
1—2000 KW **Westinghouse Turbine** with Surface Condenser and auxiliaries 3-60-440 volts.
1—300 HP **Kerr** Non-condensing 3600 RPM volts.
1—250 KVA **Waite Turbine** either condensing or non-condensing.
1—250 KVA **General Electric non-condensing Turbine.**
1—125 KW **General Electric non-condensing Turbine.**

ENGINE GENERATOR SETS

260 KVA **Skinner** uniflow engine.
1—750 KVA **Rice & Sargent** 3-60-600 volt engine generator.
2—200 KW 250 volt D.C. **engine generator sets.**
1—250 KVA **Ridgeway** engine generator set.
1—500 KVA **Allis-Chalmers** Corliss.
17 inch by 18 inch **Skinner** uniflow engine.
1—166 KVA **Ames Uniflow engine generator set.**
1—260 KVA **Skinner** uniflow engine.
2—625 KVA **Bates Corliss** engines.
1—48" x 150' **steel stack.**

DIESEL ENGINES

2—200 KVA **Fairbanks-Morse** Full Diesel **Engine Generator.**
4—312 KVA **MAN** full diesel engine generators, solid injection, 4 cycle.
1—**Busch Sulzer** Full Diesel direct connected 1335 KW AC **generator,** rebuilt and guaranteed.
1,250 KVA **Nelesco** engine generator.

ENGINE GENERATOR SETS

1—625 KVA **Nordberg** Uniflow engine.
1—1000 KVA **Skinner** Uniflow engine.
400 KW **Skinner** Uniflow **Engine Generator set.**

MISCELLANEOUS

54,000 pound **Cochrane** hot process lime and water softener.
2500 HP **Cochrane** Open Feed Water Heater.
1—10' x 15' **Illinois** Forced Draft Chain **Grate Stoker.**
1—#8 **Fuller Bonot Pulverizer.**
1—8 retort **Taylor,** brand new stoker.
1—800 HP **Hoppes** open feedwater heater.

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FLETCHER SALES CO.

325 Fincastle Building — LOUISVILLE, KY.

POWER PLANT EQUIPMENT CO., Inc.

39 Cortlandt Street
New York, N. Y.

A C TURBINE UNITS

6250 KVA G.E. 2300 V., cond.
4000 KVA Al. Chal. 2300 V. cond.
3750 KVA G. E. 2300 V. cond.
3125 KVA G.E. 4100/2300 V. cond.
2500 KVA G. E. 2300 V. cond.
2500 KVA Al. Chal. 440 V., cond.
1875 KVA Al. Chal. 2300 V. cond.
1250 KVA (2) G. E. 2300 V. cond.
940 KVA Wghse. 6600 V. cond.
937 KVA G. E. Auto BLEEDER, 2300 V.
937 KVA G. E. 2300 V., cond.
937 KVA Al. Chal. 2300 V., 300#.
780 KVA Al. Chal. 2300 V., cond.
625 KVA Wghse. 2300 V., cond.
375 KVA G. E. 2300 V., cond.
312 KVA Elliott 480 V., cond.
250 KVA Al. Chal. 480 V. Auto BLEEDER.
150 KVA Wghse. 240 V. cond. (Non Cond.)
375 KVA G.E. 2300 V.
312 KVA C.W.—Moore, 450#, 240 V.
175 KVA Al. Chal.—Sturtevant 220 V.
75 KVA Al. Chal. 240 V.

STEAM ENGINE SETS (A C)

500 KVA (2) G. E.—24 x 48 Bates Corliss.
490 KVA Wghse.—Hamilton Cross Comp.
420 KVA Wghse.—Erie Ball Cross comp.
375 KVA G. E.—22 x 27 Erie Ball, 4 V.
210 KVA G. E.—19 x 20 Skinner Unif.
150 KVA G. E.—16 x 15 Skinner Unif.
150 KVA G. E.—16 x 36 Skinner S. V.
125 KVA G. E.—12 x 21 Hamilton 4 V.
100 KVA G. E.—14 x 15 Skinner Unif.

DIESEL ENGINE SETS

500 KVA Wghse.—Busch Sulzer
375 KVA Wghse.—Busch Sulzer
312 KVA G. E.—Anderson
312 KVA G. E.—McIntosh Sey.
200 KVA G. E.—Busch Sulzer
170 KVA F. M.—F. M. "VA"
140 KVA E. M.—Fairbanks Morse "V"
121 KVA F. M.—F. M., 32-E
100 KVA C. W.—Bessemer
90 KVA (4) F. M.—F. M. "VA"
75 KVA Al. Chal.—International

BELTED

240 HP Fairbanks 35-E 6 cyl.
80 HP (3) Fairbanks Style V. A.

GAS UNIT

44 KVA Caterpillar, 3-60-220 V.

SPECIAL

937 KVA G. E. 3-60-2300 V., Auto BLEEDER. With complete equipment.
937 KVA G. E. 3-60-2300 V., Condensing. With complete equipment.

W T BOILERS

749 HP (2) Edgemoor, 200#
728 HP Erie City, Ver. 200#
600 HP Connelly, 200#
522 HP Kidwell 207#, 3 drum
471 HP Erie City Ver., 160#
396 HP B. & W., 160#
275 HP Heine 150#
250 HP Sterling, 160#
200 HP (2) Scotch Marine, 15#

PUMPS (MOTOR DRIVEN)

7500 GPM 80' head
4000 GPM 70' head
3600 GPM 85' head
3250 GPM 425' head
3000 GPM 100' head
3000 GPM (2) 65' head
1390 GPM 231' head
850 GPM 243' head
750 GPM Hill 231' head
350 GPM 720' head

STEAM ENGINE SETS (D C)

450 KW C. W. 250 V.—Nordberg Unif.
300 KW G. E.—Skinner Unif.
150 KW G. E.—Erie Ball 4 V.
100 KW G. E.—Erie Ball 4 V.

AIR COMPRESSORS

2200 CFM Nordberg 100#, steam and motor driven
1080 CFM Nordberg 85#,—motor Steam driven—all sizes Gas driven—80-100 HP, 200/300#
500 CFM Ingersoll 100# motor

TRANSFORMERS

687 KVA (2) Maloney 13800-460 V.
500 KVA (3) Al. Chal. 33000-440 V.
500 KVA (2) G. E. 11950/6900-230/460 V.
250 KVA (2) G. E. 6600-2300 V.
150 KVA (2) Maloney 2300-230/460 V.
150 KVA (2) Furnace Type 6600-90
100 KVA (3) Al. Chal. 22000-440 V.
100 KVA (2) G. E. 13200/6600-440/600 V. & small sizes.
3 Ph. Transformers
750 KVA Wagner 6600-2200 V.
500 KVA (4) G. E. 13200-120/208 V.
300 KVA (2) G. E. 13200-120/208 V.

THE PICK OF POWER EQUIPMENT

TURBO UNITS—60 Cy.

1—15300 KVA Westinghouse Cond.
1— 6250 KVA General Electric Cond.
1— 6000 KVA Westinghouse Cond.
1— 4000 KVA General Electric Cond.
1— 4000 KVA Allis Chalmers Cond.
1— 3125 KVA General Electric Cond.
1— 3125 KVA Westinghouse Cond.
1— 2500 KVA Allis Chalmers Cond.
1— 2500 KVA Westinghouse Cond.
1— 2500 KVA General Electric Cond.
1— 1563 KVA General Electric Cond.
1— 1563 KVA Westinghouse Extrac.
1— 1250 KVA General Electric Cond.
1— 937 KVA General Electric Cond.
1— 750 KVA General Electric Cond.
1— 1500 KVA Allis Chalmers Non-C.
2— 1250 KVA General Electric Non-C.
1— 938 KVA West. 375# I.P. 100# B.P. N-C.
1— 625 KVA General Electric Non-C.
1— 470 KVA Westinghouse Non-C.
1— 312 KVA Moore Non-Condensing
1— 250 KVA Westinghouse Non-C.
1— 125 KVA Westinghouse Non-C.

STEAM ENGINE UNITS—60 Cy.

1—1067 KVA Nordberg Uniflow
1— 375 KVA Nordberg Uniflow
1— 325 KVA Skinner Uniflow
1— 300 KVA Hamilton 4-valve
1— 210 KVA Skinner Uniflow
1— 187 KVA Skinner Uniflow
1— 150 KVA Skinner Uniflow
1— 100 KVA Skinner Uniflow
1— 94 KVA Ridgway 4-valve
1— 93.8 KVA Skinner Uniflow
1— 60 KVA Skinner Uniflow

D.C. STEAM ENGINE UNITS

1—350 KW Ridgway 4-valve 250 V.
1—300 KW Skinner Uniflow 250 V.
1—250 KW Ames Uniflow 250 V.
1—150 KW Ames Uniflow 125 V.
1—125 KW Ridgway 4-valve 250 V. 3-wire
1—100 KW Ames Uniflow 120 V.
1—100 KW Elliott 4-valve 250 V. 3-wire

OIL & GAS ENGINE UNITS—60 Cy.

1—500 KVA West. (gas) 440 V.
1—312 KVA Anderson 2400 V.
1—200 KW Worthington 2300 V.
1—200 KVA Fairbanks Morse VA 2400 V.
1—187 KVA McInt.-Seymour 2300 V.
1—125 KVA Sterling Petrel (gas)480 V.
3—120 KVA Cooper Bessemer 220 V.
1— 75 KVA General Motors 120/208 V.
1— 44 KVA Venn Severin 230 V.
1— 37.7 KVA Caterpillar 120/208 V.

SURFACE CONDENSERS

1—20,000 sq. ft. Worthington
1—12,000 sq. ft. Worthington
1— 5,000 sq. ft. Westinghouse
1— 4,100 sq. ft. Ross
1— 2,310 sq. ft. Wheeler C. & E.

WATER TUBE BOILERS

1—750 HP Edge Moor 200-lb.
1—612 HP Stirling 250-lb., Pulverizer
2—560 HP Erie City 460-lb.
1—500 HP Stirling 250-lb., Stoker
1—500 HP Stirling 200-lb., Stoker
1—440 HP B. & W. 160-lb., Hand Fired
1—400 HP Wickes 200-lb., Stoker
1—335 HP B. & W. 200-lb.
4—200 HP B. & W. 200-lb., Hand Fired

A.C. GENERATORS

2—1500 KVA G.E. 25 cy. 2200 V. 750 RPM
2—1250 KVA G.E. 60 cy. 480 V. 750 RPM
1— 750 KVA G.E. 60 cy. 230-460 V. 300 RPM
1— 680 KVA G.E. 25 cy. 13200-4000 V. 300 RPM
1— 500 KVA G.E. 60 cy. 2300 V. 360 RPM
1— 360 KVA West. 60 cy. 240 V. 360 RPM
1— 94 KVA G.E. 60 cy. 2300 V. 600 RPM
1— 48 KW Elec. Mcy. 60 cy. 2400 V. 1200 RPM

SYNCHRONOUS MOTORS

2—1250 HP G.E. 25 cy. 2200 V. 750 RPM
2—1125 HP G.E. 60 cy. 480 V. 720 RPM
1— 850 HP G.E. 25 cy. 13200-4000 V. 300 RPM
1— 800 HP G.E. 60 cy. 440 V. 120 RPM
1— 770 HP G.E. 60 cy. 230-460 V. 300 RPM
1— 100 HP G.E. 60 cy. 2300 V. 240 RPM (Super)

INDUCTION MOTORS—60 Cy.

4—3500 HP G.E. slip ring 2300 V. 120 RPM
1—1000 HP G.E. sq. cage 2300 V. 509 RPM
1— 600 HP G.E. sq. cage 440 V. 900 RPM
2— 400 HP G.E. slip ring 3800 V. 1800 RPM
2— 300 HP G.E. sq. cage 440 V. 600 RPM
2— 250 HP G. E. cage 2300/4000 V. 1200 RPM

MOTOR GEN. SETS—60 Cy.

1—1500 KW Allis Chalmers 600 V. DC
1—1000 KW General Electric 600 V. DC
1—1000 KW Westinghouse 250 V. DC
1— 75 KW General Electric 125 V. DC
2— 70 KW General Electric 125 V. DC

ROTARIES—60 Cy

1—1500 KW Westinghouse 250 V.
2—1000 KW Westinghouse 250 V.
2— 750 KW General Electric 600 V.
1— 750 KW Westinghouse 225/275 V.
1— 500 KW General Electric 250 V.
1— 500 General Electric 600 V.

FREQUENCY CHANGERS

2—3125 KVA West. 25/62½ cy. 750 RPM
1—3000 KVA G.E. 60/25 cy. 300 RPM
1—2500 KVA West. 25/60 cy. 300 RPM
1—1875 KVA G.E. 25/60 cy. 300 RPM
2—1250 KVA G.E. 25/62½ cy. 750 RPM
1—1250 KVA G.E. 25/60 cy. 300 RPM
1— 750 KVA G.E. 25/60 cy. 300 RPM
1— 750 KVA G.E. 60/25 cy. 300 RPM

SYN. CONDENSERS—60 Cy.

1—5000 KVA West. 5000 V. 720 RPM
1—2000 KVA C.W. 11000 V. 600 RPM
2—1250 KVA G.E. 480 V. 720 RPM
1— 750 KVA G.E. 230-460 V. 300 RPM
1— 500 KVA West. 2200 V. 900 RPM

TRANSFORMERS—1 Ph. 60 Cy.

1—10000 KVA West. 120,000/66000-13200 V. 3 ph.
3— 750 KVA Pitts. 66000/33000 V.
3— 200 KVA G.E. 66000-13200/22800 V.
6— 250 KVA Penn. 34500-4600/2300 V.
3— 75 KVA G.E. 33000-13200/11000 V.
2—10000 KVA West. 26400-4580 V. 3 ph.
1— 6000 KVA West. 26400-2300 V. 3 ph.
1— 6000 KVA West. 13200-2300 V. 3 ph.
3—1500 KVA Pitts. 22000-6600 V.
2— 1000 KVA G. E. 23000/11500-575 V.
6— 833 KVA G.E. 22000-2300/4000 Y V.
3— 667 KVA Packard 23000-440 V.
3— 250 KVA G.E. 22000-11000 V.
6—1667 KVA Pitts. 13200-2300 V.
5—1000 KVA G.E. 13200-2300 V.
3— 200 KVA G.E. 13200-2300 V.
7— 667 KVA Moloney 11000-2300 V.
3— 150 KVA Pitts. 11000-2400 V.
3— 100 KVA West. 11000-250/125 V.
3—1250 KVA G.E. 6600-550 V.
3— 667 KVA G.E. 2300/4000Y-500/480/460 V.
5— 100 KVA G.E. 2300-230/460 V.

VOLTAGE REGULATORS
60 Cycles Induction

6—96 KVA 400 A. 2400 V. Gen. Elec.
1—72 KVA 300 A. 2400 V. Gen. Elec.
2—46 KVA 200 A. 2300 V. West.
6—36 KVA 150 A. 2400 V. Gen. Elec.
6—24 KVA 100 A. 2400 V. Gen. Elec.

OIL CIRCUIT BREAKERS

2— 400 A. 73 KV G.E. FKO36 Outdoor
1— 400 A. 73 KV G.E. FHKO36 Outdoor
6— 400 A. 37 KV G.E. FHKO136 Outdoor
4— 400 A. 34.5 KV Condit D-16-A Outdoor
2—1000 A. 30 KV Kelman CB76 Outdoor
4— 600 A. 15 KV G.E. FKO60B Outdoor
2— 400 A. 15 KV G.E. FHKO136 Outdoor
1—2000 A. 15 KV West. E6 Indoor
1—1500 A. 15 KV West. E6 Indoor
2—1500 A. 15 KV G.E. FK12 Indoor
3— 600 A. 15 KV G.E. FK32C Indoor

PARTIAL LIST—WE HAVE ALL CLASSES OF POWER EQUIPMENT

BREW, WOLTMAN & Co., INC.

50 CHURCH STREET, NEW YORK CITY 7, NEW YORK

JUST A FEW ITEMS OF OUR COMPLETE STOCK FOR IMMEDIATE SHIPMENT

PUMPS

G.P.M.	Head	Make	Type
9700	110′	Ing. Rand	Centrif.
6000	33′	LeCourtenay	Centrif.
3500	140′	Kingsford	Centrif.
2500	150′	Goulds	Centrif.
1100	220′	Allis-Chalm.	Centrif.
1000	176′	Cameron	Centrif.
400	625′	LeCourtenay	Centrif.
250	525′	LeCourtenay	Centrif.
300	500′	Goulds	Triplex
175	500′	Worth.	Triplex
500	175′	Blackmer	Rotary
450	231′	Kinney	Rotary
200	175′	Blackmer	Rotary
1000	460′	Knowles	Steam
500	460′	Knowles	Steam
2000	50′	Lawrence	Sump
300	231′	Gardner	Plunger

STEAM ENGINE GENERATOR SETS
BOILER FEED PUMPS

K.W.	Make	Volts	Type
100	Ames	240	dir. dr. Eng.
75	Ames	120-240	dir. dr. Eng.
50	G.E.	250	dir. dr. Eng.
35	Sturt.	250	belt dr.

MOTORS (D. C.)

100	Northwest	220	1750
25	Imperial	220	450

STORAGE TANKS

5 to 30000 Gal. Steel Welded
5 to 1000 Gal. Steel Press.
15 to 300 Gal. Conden. Tanks

CONDENSATION RETURN UNITS

Nash-Jenn Dup. Vac. Heat. 26000EDR
Nash-Jenn Sump Vac. Heat. 16000EDR
Skidmore Vac. Heat. 8000EDR
Condensation Units 100 to 250,000EDR

AIR COMPRESSORS

C.F.M.	Pressure	Make	Type
850	100	Laidlaw	Hor. Dup.
500	60	Ind. Rand	Steam
400	125	American	Horiz.
350	40	Worthing	Horiz.
250	100	Sullivan	Horiz.
220	100	Gardner	Gas Eng.

TURBO-CENTRIFUGAL BLOWERS

3000	16 lbs.	In. Rand	Motor dr.
2300	3 lbs.	Spencer	Motor dr.
950	24 oz.	Spencer	Motor dr.
900	5¼ lbs.	In. Rand	Motor dr.
700	2½ lbs.	Allen Billmyer	Motor dr.
675	24 oz.	Spencer	Motor dr.
250	16 oz.	Spencer	Motor dr.
60	14 oz.	Spencer	Motor dr.

BLOWERS

C.F.M.	St. Pres.	Makes	Type
100–60000	¼"–5"	Buffalo	Various
100–15000	¼"–16 oz.	American	Various

ROTARY PRESSURE BLOWERS

C.F.M.	Press.	Make	Type
10000	2 lbs.	Roots	Belt dr.
6000	3 lbs.	Roots	Belt dr.
3000	3 lbs.	Roots	Belt dr.
2000	3 lbs.	Sturt.	Belt dr.
1000	3 lbs.	Roots	Belt dr.
200	5 lbs.	Baker	Dir. dr.
110	15 lbs.	Beach R.	Belt dr.

VACUUM PUMPS

1000	15 in.	Roots	Belt dr.
350	27 in.	Worth.	Belt dr.
300	27 in.	Nash	Belt dr.
100	27 in.	Deane	Belt dr.
200	29 in.	Devine	Belt dr.

MOTORS (3 ph. 60 cy.)

H.P.	Make	Volts	Speed	Type
300	G.E.	2300/4000	1800	Syn.
175	G.E.	440	1150	I
100	Lincoln	220	1750	
75	Wagner	440	1750	
50	Wagner	220	850	Syn. 2 ph
50	G.E.	2300	1750	I
50	West.	220	850	CCL
50	West.	220	570	CS
40	G.E.	220	870	342
30	Wagner	220	850	sl. rg.
30	Wagner	220	1150	

SIMILAR EQUIPMENT IN STANDARD MAKES AND SMALLER SIZES
HIGHEST PRICES PAID FOR YOUR SURPLUS EQUIPMENT

SUPERIOR EQUIPMENT CO.

140 Grand St., N. Y. C. Tel. CAnal 6-6983-4

STEAM ENGINES

11"x12" G. E. Vertical
10"x10" Sturtevant Vertical
10"x10" Greenfield Vertical
7"x7" Wickes Bros. Vertical
6"x6" Lawrence Vertical
1 to 40 H.P. Steam Turbines

Electrical Equipment In Stock Rebuilt and Guaranteed

230-VDC. CRANE & MILL MOTORS
(Series and Compound)

H.P.	Make	Type	R.P.M
1—1	F. & H.	5½x3½	850
2—2	Shaw	Class B.E.	930
1—2½	G.E.	C.O.-2502	750
1—2½(new)	Reliance	T-224	1600
4—3	Shaw	B.E.	750
1—3½	G.E.	C.O.-2503	975
1—7/10	G.E.	M.D.-102	1025/800
1—7½	G.E.	C.O.-1805	700
1—10	C.W.	B.W.	650
1—20	G.E.(115-V)	C.O.-2504	850
2—20/30	G.E.	M.D.-104 (C.P.)	725/575
3—25	G.E.	C.O.-1809	850
2—30/45	G.E.	M.D.-164½(C.P.)	625/500
1—50	G.E.	C.O.-1810	725
2—65/85	G.E.	C.O.-1830	700/650
1—85	G.E.	C.O.-1811	550

(All Motors Are Series Wound Except Where Marked C. P. Compound)

220/440-VAC., 3-PH., 60-CY. MOTORS
(CRANE TYPE)

H.P.	Make	Type	R.P.M.
1—7½	G.E.	MTC-5952	855
1—7½	G.E.	MTC-5946	1200
1—11	P. & H.	HW-10-A	820
1—11	Westgshe	C.I.-452-A	1160
1—11	G.E.	ITC-5008	900
1—11	Louis Alll	Crane	1200
1—15	G.E.	ITC-5008	1200
1—15	G.E.	MTC-5300	1100
1—15	Electro. Dyn.	F.R.-1601	1145 (2-PH)
1—15	G.E.	M.Q.C.	1200 (2-PH)
1—22	G.E.	ITC-5009	1135
1—30	Westgshe	M.W.	1150
1—35	Westgshe	C.I.	720 (2-PH)
1—35	Westgshe	C.I.-885	950 (2-PH)
1—52	G.E.	I.T.C.-5013	600
1—50	Westgshe	C.I.-6440	870

(Can Supply Electric Brakes With Most Of These Motors)

SPECIAL:
(3)—EC&M Youngstown Limit Switches.
(1)—EC&M Magnet control. 230 VDC master controller, contactor and resistor.
(1)—Spring type magnet cable reel with rubber covered cable.

GENERAL PURPOSE 230-VDC MOTORS

H.P.	Make	Type	R.P.M.
2—2	Allis. Chal.	E-50	1750-SH.
1—3	G.E.	CD-55	1150-SH.
1—3	Reliance	T-224	3500-SH.
3—5	Westgshe	SK-40	850-SH.
2—5	Westgshe	SK-30	1100-Comp.
4—5	Westgshe	SK-30	1100-SH.
2—7½	Westgshe	SK-60	850-Comp.
1—7½	Westgshe	SK-40	1150-SH.
1—10	Westgshe	SK-50-L	1300-SH.
1—15	Allis. Chal.	Shunt	800
1—15	C.W.	Size 15-J	800-Comp.
1—15	G.E.	CD-75	1750-SH.
2—25	Westgshe	SK-100-L	1100-SH.
1—40	Reliance	RH-992	1200-Comp.
1—75	Westgshe	SK-160	850-Comp.

230-VDC. VARIABLE SPEED MOTORS

H.P.	Make	Type	R.P.M.
1—2	G.E.	RF	500/2000
1—3	G.E.	RLC-111	750/1500
1—3½	G.E.	RLC-112	600/1800
1—5	Westgshe	SK-33	1150/1650
1—7½	Westgshe	SK-103	400/1600
1—8	Westgshe	SK-100L	300/1200
1—20	G.E.	RF-12	400/1200
1—25	Reliance	310-T	300/1200
1—70	Reliance	461-T	600/1200

(Auto Control Panels With Most of These Motors)

220/440-VOLTS, 3-PHASE, 60-CYCLE MOTORS (GENERAL PURPOSE)

H.P.	Make	Type	R.P.M.
1—1½	G.E.	K.T.-180	1800/1200/900/600
2—3½	G.E.	K.T.-180	1800/1200/900/600

(Above With Special G.E. Drum Controls)

1—5	G.E.	K-454(vert)	1735
1—7½	Sprague	MT-181	1800 (S.R.)
2—7½	Louis Allis	OX-28	1740
1—7½	Westgshe	C.S.	1200
1—10/20	G.E.	KT-522-Y	600/1200
1—10	F.M.	OS-FW-324	1740
1—12½/25	Westgshe	C.S.	880/1730 (A.C.)
1—20	C.W.(B.B.)	ALS-404	1150 (A.C.)
1—20	G.E.	1	1200
1—25	Westgshe	C.S.	900
1—25	F.M.	H-12-B	900
2—25	F.M.	H-12-A	1200
1—25	G.E.	KF-405	1170
2—25	G.E.	KT-326	1200
1—35	F.M.	H-12-B	1200
1—35	G.E.	1-form-K	1800
1—50	G.E.	KT-346	870
1—75	Westgshe (S.R.)	C.W.-753-C	870 (A.C.)

(B. B. Ball Bearing; S R. Slip Ring; A. C. Automatic Control)

SPECIAL:
14—Master Electric Motors, Explosion Proof Fan Cooled, 2-HP., 1725-RPM. 220/400-V., 3-PH., 60 CY, Ball Bearing, with Mercury Clutch, Master Speed Ranger, Speeds 700-900-1060, 1260-1500-1780-2100-RPM.

T. B. MacCABE COMPANY
4306 CLARISSA ST. PHILADELPHIA 40 PA.

AVAILABLE FOR IMMEDIATE DELIVERY
POWER PLANT EQUIPMENT

5000 KW Westinghouse Turbo Generator Set: Turbine 3600 RPM, 200# pressure, 125° superheat, Complete with Condenser, Pump, and Airwasher. Generator: 6250 KVA 3 phase 60 cycle 2300 volt 3600 RPM with turbo Exciter and Motor Generator Exciter.

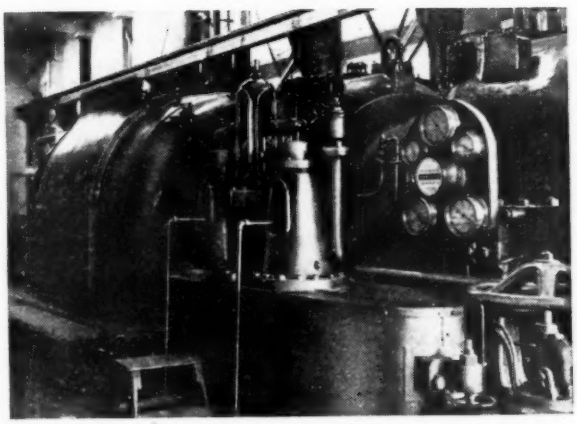
4—1010 HP Heine Watertube Boilers 250# pressure Complete with Superheaters, Bethlehem Dahl Oil Burners, All Valves, Piping and Fittings.

1—G.E. Electric Pantograph Locomotive Standard Gauge 20-Ton—500 Volt D.C. Complete.

1—Vulcan Gasoline Locomotive Standard Gauge Fourwheel Drive.

2—Westinghouse Stokers for 750 HP Boilers.

2—Westinghouse 40 HP Geared Motors 440 V. 3 ph. 60 cyc. 258 RPM.



THIS EQUIPMENT WILL BE SOLD IN INDIVIDUAL UNITS IF DESIRED

HEAT and POWER Company,
45 BOND STREET ALgonquin 4-3874 NEW YORK 12, N. Y.

CHICAGO ELECTRIC—GUARANTEED REBUILT EQUIPMENT

2—1500 KW MGS.
2—1500 KW Wtg. 250 d.c. dir. conn. 2250 hp. Syn. 360 rpm. 3-60-12000/2300 V.

MOTOR-GENERATOR SETS

KW	Make	DC volts	AC volts
1500	Wtg.	250	2300 SYN
1000	G.E.	600	4400/2200
1000	Wtg.	275	4160/2300
750	G.E.	275	440
300	Al. Ch.	600	2300 syn.
250	G.E.	600	
200	3-unit	80v.DC	250 v. DC
235	Westg.	110	2200
225	Ideal	115	2200
200	Westg.	250	440/2200
150	Cr. Wh.	250	2300
150	Ideal	250	440
150	Rldg.	250	2300
100	G.E.	250	2200
100	Westg.	125	2200
100	Al. Ch.	125	440
100	Westg.	250	220/440/2200
90 HP	Westg.	110	75 Kva 2200 ac
75	G.E.	250	2200
75	G.E.	125	220
50	Al. Ch.	3-w.	2200
50	G.E.	125	4000
50	Westg.	250	2300
15	G.E.	230	220
15	Ster.	240	220
7½	Jenny	balance set	

SLIP RING MOTORS

Qu.	HP	Make	Type	Speed
1	30	Wagner	BR	850
1	30	Westg.	HF10A	860
1	15/35	Westg.	CW654C	575/1150
1	30/15	G.E.	OMT336	1155/550
1	35	F. Mse. vert.	UVA	1800
1	35	G.E.	I-M13	600
1	35	G.E.	I-M-13	600
1	40	G.E.	MT-int.	1200
1	40	Wagner	22TBR	1725
1	40	Westg.	CW	1160
1	40	Wagner	BR	850
1	40	Westg.	HF	690
1	50	Westg.	HF11AH	1180
1	50	Al. Ch.		1160
1	50	West.	HF	860

2—1500 KW M.G. SETS

2—1500 KW Westinghouse, interpole, 250 volts, D.C. generators, speed 360 RPM, with commutating interfield poles, connected to
2—2250 KVA Westinghouse synchronous motors, 3 phase, 60 cycle, 12000/2300 volts, 360 RPM, with DC and AC switchboard equipment, excellent condition, available immediately.

FREQUENCY CHANGER

1—1400 HP General Electric type ATI-24-1250M-300 Form C, 3 ph. 60 cy. 460 volt, 300 RPM, 1570 amps, 1250 KVA, 0.9 P.F. synchronous motor with amort. wdg., dir/conn. to 1000 KW General Electric types ATI-10-1250M-300, 3 ph, 25 cy, 450 volts, 300 RPM, 1570 amps, 1250 KVA, 0.8 P.F. A.C. generator with amort. wdg., with 33 KW G. E. 125 volt direct connected exciter. (This is a three brg. unit suitable for operation from either end.)

SLIP RING MOTORS

Qu.	HP	Make	Type	Speed
1	50	F.M.	HV	720
1	50	Westg.	CW752C	690
1	50	G.E.	I-M	685
1	50	Al. Ch.	ARY	690
1	50	G.E.	I-M	600
1	50	Wtg.	CW855	570
1	50	G.E.	MTC5342	565
1	50	Al. Ch.		720
1	60	Westg.	CW	600
3	75	Al. Ch.	ARY	900
1	75	Westg.	F	720
1	75	G.E.	M-12	600
1	75/94	N. West	HW	1800
1	100	G.E.	I	600
1	100	Al. Ch. 2200 v.		600
1	100	Westg. 2200	CW	600
1	100	Westg.	HF	230
1	150	G.E.	MT	900
1	150	Westg.	CW	600
1	150	Al. Ch.		580
1	150	Wagner	BR	1140
1	150	Westg. 2200	CW	375
1	200	G.E.	IE	1200
1	200	Howell	S	600
1	200	Westg.	CW	345
1	250	Al. Ch. 2200/400		600
1	250	G.E. Slipring vert.		1200
1	300	G.E. Slipring	I-M2200	514
1	300	G.E., 3-brg.	MT-410	450
1	300	G.E. with outboard brg.	I-P	450
1	350	G.E.	MT-432V-	300
1	350	Allis C.		300

VARIABLE SPEED MOTORS
230 Volt D. C.

HP	Make	Type	Speed
1	Cr. Wh.	CM	500/1000
1	Electro-Motor		420/1680
1½	Cr. Wh.	CM	925/1210
2	G.E.	RC4	600/1000
3	Gen. Elec.	CD	1050/1700
4	Sprague	C	800/1400
5	Burke	AM12	500/1500
5	Burke	Wam12	960/1950
7½	Reliance	46T	875/1200
12½	G.E.	C	700/1400
20	G.E.	RF12	500/1500
20	G.E.	RLC	500/1500
20	G.E.	RC11	500/1500
25	G.E.	DLC	500/1000
35	Wtg.	SK140	500/1500
40	G.E.	LC	825/2000
40	Chandysn.		250/1500
50	Gen. Elec.	RC14	500/1500
50	G.E. Sprague	C	575/1000
50	Westinghouse	SK	500/1000
60	Electro Dyn.		450/900
90	Westinghouse	SK	575/1150
35/100	G.E.	CD165	425/850
100	Gen. Elec.	CD147	450/1150
100	Gen. Elec.		1100/1800
200	Gen. Elec.	MD	300/450
700	Gen. Elec.	MPC	450/600

BOILERS

100—HP Scotch Marine 100#
2—500 HP B & W 200# ASME
2—750 HP Edgemoor 175#
2—300 HP Keeler 175#
1—516 HP B & W 20#, stoker
2—250 HP Union, Taylor stoker
2—240 HP Almy180#
3—308 HP Heine ASME 180#
2—200 HP Scotch Marine 165#

GAS ENGINES

15 kw 115 or 230 volt DC Gen. with Universal prod. gasl. engine.
25 kw 115 v. DC. gen. with 4-cyl. gas engine.
600 amp. 25 v. Lincoln Welder with Waukesha gasl. engine.

SQUIRREL CAGE

1	75	Al. Ch.	AN	680
3	75	Al. Ch.	345	
5	75	G.E.		600
1	100	Al. Ch.		1800
1	100	Al. Ch., vert.		1200
3	100	Westg., 2200/220/440	CS	1200
1	100	West. El.	KT	900
1	100	G.E., 2200 v.	IK	900
1	100	Al. Ch., 2200 v.		450
2	125	G.E., 2200 v.	KT547	1800
2	125	G.E., 2200 v.	KTP	1800
4	125	G.E.	KT	720
1	150	Westg., 2200 v.	CS	1716
1	150	Al. Ch.		1200
1	150	G.E.	K-558	900
1	150	Westg., 2200 v.	CS	1800
1	150	G.E.	IK	600
2	150	Westg.	CCL	495
1	200	Westg.	CS	3600
3	200	F. Morse, B.B.		1800
1	200	G.E., 2200 v.	KT	1800
1	200	G.E.	IK	1200
1	200	G.E.	IK	600
1	200	Westg.	CS	600
1	225	G.E., 4160 v.	FT	3600
1	225	G.E., 2200	I-E	1800
1	250	Fair, M.B.B., 2200 v.		1800
1	250	Ideal	A	1200
1	250	F. Morse B.B.	3-brg.	900
2	400	G.E., 2200 v.	I-K	1800
1	400	Al. Ch.		600
1	700	G.E., 2200, drip-proof constr.	KF	1800
1	1000	G.E., 2200 v.	K	500

CHICAGO ELECTRIC CO. 1320 W. CERMAK RD. CANAL 2900 CHICAGO 8, ILL.

MOTORS • GENERATORS • TRANSFORMERS

Prices on Application
3 PHASE, 60 Cycle, 220/440 V.

HP	Make	RPM	Type	Frame
7½	Gen. Elect.	1200	KT	952
10	Gen. Elect.	720	K	404
10	Gen. Elect.	900	KT	312
15	West.	1800	CS	
20	Gen. Elect.	900	KG	405
20	Armor	900	ball bearing	
20	Fairbanks Morse	900	ball bearing	
20	Fairbanks Morse	1200 600	two speed	
25	Westinghouse	900	CS	444
30	Armor 2-phase	720	ball bearing	
40	Westinghouse	1800	CS	
50	Gen. Elect.	1800	IK	
50	Westinghouse	900	CS	505
50	Westinghouse	900	CS	646A
50	West.	1800	CS	
60	Gen. Elect.	1800	I	form K
75	Gen. Elect.	1800	I	form K
75	Gen. Elect.	900	KT	552
100	Gen. Elect.	1800	I	form K
100	West.	1800	CS	
150	Gen. Elect.	1200	I	form K
150	Gen. Elect.	1200	I	form K

TRANSFORMERS

Amt.	Kva.	Make	Cycle	Voltages
3	25	Gen. Elect.	25	2300/115/230
3	50	Gen. Elect.	25	2300/115/230
3	75	Gen. Elect.	60	4600/230/460
3	100	Gen. Elect.	25	2300/115/230/460
2	150	Westinghouse	25	2300/115/230/460
3	200	Gen. Elect.	60	2300/230/460
3	250	Gen. Elect.	60	13,000/2300
3	250	Westinghouse	60	11500/460
2	333	Westinghouse	60	2300/230/460
3	500	Pittsburgh	25	11,000/220
4	833	Allis Chalmers	60	13,200/440
3	1000	Pittsburgh	60	2300/4600/230/460

SPECIAL
3—250 KVA. Westinghouse Transformers Type SL 11,500 volts Primary 460 volts. Secondary, 60 cycle 1 phase. Used less than 1 year.

Mine Slope Hoist

1—Connellsville Mfg. and Mine Supply Hoist storage capacity for 11,000 feet 1" Rope—Speed 900' per minute.
Motor—500 HP Gen. Elec. Mt. Slipring 3/60/2200/450 RPM. Complete with remote control, Herringbone reduction gears and demountable base and drum.
Write Wire Phone
Inspection can be made for 30 days in operation. This machine almost new.

MOTOR GENERATOR SETS

1—125 KW Ridgeway 250 V. DC. 1200 RPM Motor 3/440/60/1200 Complete.
1—100 KW Westinghouse Synchronous-Generator 250-275 V. DC—Motor 3/60/2300/900 RPM complete with panels.
1—150 KW Westinghouse Synchronous-Generator 250-275 V. DC. Motor 3/60/2300/900 RPM complete with panels.

3 PHASE, 25 CYCLE, 220/440 VOLTS

HP	Make	RPM	Type	Frame
5	Al. Chal.	720	AR	
5	Wagner	1450	Ball B.	Enclosed
7½	West.	750	CS	
7½	G.E.	1500	KT	181
10	G.E.	750	KT	312
10	West.	750	CS	
10	West.	1500	CS	
10	G.E.	1500	I	Form K
15	G.E.	750	KT	
15	West.	1500	CS	
20	West.	750	CS	
25	West.	750	CS	
50	G.E.	750	I	Form K
50	West.	750	CS	
75	G.E.	750	KT	357
75	G.E.	750	I	Form K
100	G.E.	300	I 17	Form K
150	G.E.	750	I	Form K
150	G.E.	750	I	Form K
200	West.	460	CS	2200 Volt
200	G.E.	750	I	Form K
225	Elec. Ma.	500	2200 V.	Synchron
1150	G.E.	375	2300 V.	Synchron
200	West.	235	CW	Slipring

Prices on Application
SLIPRING MOTORS
60 CYCLE, 3 PHASE, 220/440 VOLTS

HP	Make	Speed	Type	Frame
10	Gen. Elect.	1800	MT	303
15	Gen. Elect.	1800	I	form M
20	Gen. Elect.	545	MT	332
20	Westinghouse	575	CW	648A
20	Westinghouse	575	CW	ball bearing
25	Westinghouse	690	CW	
30	Gen. Elect.	1800	MT	327
30	Gen. Elect.	1800	I	form M
40	Westinghouse	690	CW	748
40	Westinghouse	690	CW	748A
40	Westinghouse	690	CW	748A
40	Westinghouse	690	CW	748A
50	Westinghouse	900	CW	
60	Westinghouse	720	CW	2200 volt
75	Westinghouse	1800	CW	
500	Westinghouse	600	CW	

SPECIAL
2—500 HP. Gen. Elec. Motors, Type I, Form K, 3/60/440/900 RPM, with Starting Compensatiors.
1—500 HP. Gen. Elec. Motor, Type KTP. 3/60/440/1200 RPM with Starting Compensator.

2—1250 KVA Gen. Elec. Synchronous—motor 3/25/2200 750 RPM. direct connected to Generator 3/62½/440 V. Complete with exciters and panels.
1—200 KW General Electric 3 ph., 60 cy., 2300 V. direct connected to 200 HP. Gen. Elec. Synchronous Motor, 3 ph., 25 cy., 440 volt, 750 RPM. Complete with panels.

150 HP D.C. MOTOR
150 HP. Westinghouse Type SK, 180L, 230 V., 1100 RPM, Compound Interpole. Serial No. 2221504.

ERIE ELECTRIC CO., INC.
124 CHURCH ST. BUFFALO, N. Y. CL. 4758

1—400 HP Westinghouse, type CW, 3 ph. 60 cy, 440V, 450 RPM slip ring motor
1—250 HP General Electric, 3 ph, 60 cy, 440V, 1-17 400 RPM
1—200 HP Allis Chalmers, 3-60-440V, 514 RPM
1—150 HP Allis Chalmers, 3 ph, 60 cy, 440V, 450 RPM slip ring
1—150 HP Electric Mach. syn. motor, 125 KVA, 3-60-220V, 1200 RPM
1—150 HP General Electric, 3-60-440V frames 17A 360 RPM slip ring
1—150 HP Westinghouse, 2 ph, 60 cy, 440V frame 1000, CW. 390 RPM slip ring
4—100 HP General Electric, 3-60-440V, 495 RPM, MT 562 slip ring
2—100 HP General Electric type I, form K, 3-60-220V 575 RPM

50 KW Westinghouse, 125/250 V, type SK, frame 160, 3 wire generator direct connected to a 100 HP General Electric, type KT356, 900 RPM, 3 PH, 60 CY, 220 V motor on fabricated base.

1—100 HP Westinghouse, type CCL, 3 ph, 60 cy, 2200V, 1750 RPM, Squirrel Cage
1—100 HP Allis-Chalmers, type ANY, 3 ph, 60 cy, 220V, 690 RPM slip ring
1—100 HP G. E., 3 ph, 60 cy, 440V, 580 RPM, type 1-M slip ring
1—100 HP General Electric, 3 ph, 60 cy, 4000V, 720 RPM syn., type TS with direct connected exciter
2—100 HP Crocker Wheeler, size 2AQ, 3 ph, 60 cy, 440V, 385 RPM slip ring
1—100 HP Westinghouse, type CS, 3 ph, 60 cy, 440V, 1750 RPM sq. cage
2—75 HP 300 foot head Pumps: 2200V Fairbanks-Morse, 1800 RPM 3 ph, 60 cy, slip ring motors direct connected to 500 GPM 3 stage
1—75 HP Allis-Chalmers, 3 ph, 60 cy, 440V 450 RPM slip ring
1—75 HP Fairbanks-Morse, type H, frame 165C, 3 ph, 60 cy, 550V, 900 RPM Squirrel Cage
1—75 HP Lincoln, type IQ, 2 ph, 60 cy, 440V, 600 RPM Squirrel Cage
1—75 HP Allis-Chalmers, 3 ph, 60 cy, 440V, 600 RPM slip ring
1—75 HP General Electric, 3 ph, 60 cy, 440V, 600 RPM, MT558 slip ring
1—75 HP Western Elec. type I, 3-60-440V, 690 RPM
2—75 HP Allis Chalmers, 3 ph, 60 cy, 440V, 860 RPM slip ring
1—60 HP Lincoln 3-60-220V frame IXM, Sq. Cage, 900 RPM
1—60 HP General Electric, 3-60-440V, 720 RPM, type I, form K
1—60 HP General Electric, 3-60-440V, 1750 RPM, type I slip ring
1—60 HP Westinghouse, 3 ph, 60 cy, 220V, 1160 RPM, type CS-644C
1—50 HP Wagner (Fynn Weichsel) 3-60-440V, 1200 RPM
1—50 HP General Electric 3-60-220V, 1150 RPM, type I, slip ring
1—50 HP Triumph 3-60-440V, type C12, 1150 RPM, slip ring, rotor & stator rewound
1—50 HP General Electric, 3-60-440V, KT-346, 870 RPM, Sq. Cage
1—50 HP General Electric, 3-60-440V, 900 RPM, type I-M, slip ring
1—50 HP Howell 3-60-440V, 870 RPM, type SCBB ball bearing Sq. Cage
1—50 HP General Electric, 3-60-440V, 720 RPM, type IK, Sq. Cage
2—50 HP Allis-Chalmers 3-60-440V, 690 RPM slip ring
1—50 HP General Electric 3-60-440V, 690 RPM, MTS 46, slip ring
1—50 HP Ideal 3-60-440V, 580 RPM, type AV, slip ring
3—50 HP General Electric 3-60-440V, 575 RPM, type I-K, fr. 13A, Sq. Cage
1—50 HP Wagner 3-60-440V, 495 RPM, type BM, Sq. Cage
1—50 HP Allis-Chalmers, 3-60-440V, 490 RPM, Sq. Cage
1—50 HP General Electric 3-60-440V, 490 RPM, type I-M, slip ring
1—50 HP Westinghouse CS 2-60-440V, 420 RPM, Sq. Cage
1—50 HP Allis-Chalmers, 3 ph, 60 cy, 220V, 1160 RPM, type AR-220D
1—50 HP Howell, 3 ph, 60 cy, 440V, 1165 RPM, type SC50-4, ball bearing
1—50 HP Allis-Chalmers, 3 ph, 60 cy, 550V, 860 RPM sq. cage
1—50 HP General Electric, type I-M, 3 ph, 60 cy, 440V, 720 RPM slip ring
1—45 KVA Fairbanks Morse, 3 ph, 60 cy, 220V, 1200 RPM alternator
2—30 HP Fairbanks-Morse, 3 ph, 60 cy, 220V, 3600 RPM, type HO, frame 12B ball bearing
1—30 HP, Wagner, 3 ph, 60 cy, 440V, 900 RPM, type 19TCM, totally enclosed fan cooled, ball bearing

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2—175 HP, 230V, DC Westinghouse, type SK, 525, RPM
1—100 HP General Electric, type CD, fr. 123, 230V, 1200 RPM
1—60 HP Westinghouse, type SK, frame 160, 230V, 880 RPM
1—60 HP Westinghouse, type SK140L, 115V, 1150 RPM vertical
1—50 HP Westinghouse, type SK, fr. 160, 230V, 565 RPM
1—50 HP Westinghouse SK200, 245 RPM, 230V
1—DC Generator 45KW Bullock, 120V, 375A, 900 RPM
2—40 HP C & C 230V, 250/1000 (planer)
2—40 HP, G. E., 3 ph, 60 cy, 440V, 435 RPM, type 1-13A

25 CYCLE MOTORS

1—50 HP Westinghouse 3-25 cy-440V, 720 RPM, type MS, Sq. Cage
1—50 HP General Electric, 3-25 cy-440V, 700 RPM, type I-M, slip ring
1—40 HP Westinghouse 3-25 cy-440V, 730 RPM, type CI, frame 753A slip ring crane
1—35 HP Allis-Chalmers 3-25 cy-440V, 720 RPM, slip ring
1—30 HP Westinghouse 3-25 cy-440V, 720 RPM, CS. Sq. Cage

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6—7 x 6 Vertical, totally enclosed, Troy engines. 25 H.P. at 300 R.P.M. 40 H.P. at 400 R.P.M.—self-oiling Number of steam pumps, duplex and single acting from 3 x 2 x 3 up to 20 x 12 x 15. Some of these are new.

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L. J. LAND AND COMPANY

D. C. Motors & Generators

Partial List Only!

230 VOLT DC MOTORS

H.P.	Make	Speed
150	West.	600
60	El. Dynam.	900
60	Roth	600
60	G.E.	480/1100 (2)
50	West.	550/1100
50	Cr. Wh.	700 (2)
50	G.E.	850
45	Diehl	850/1020
40	El. Dy.	1200
40	Reliance	400/1500
40	Cr. Wh.	915
35	West.	1150
25	Diehl	850/1020
25	G.E.	1150
25	G.E.	575
20	Cr. Wh.	1750
20	R & M	1160
20	G.E.	1150 (4)
20	West.	1150
20	G.E.	800 (2)
15	West.	1250
15	G.E.	1150 (3)
15	Cr. Wh.	900/1800
15	West.	850
10	West.	850 (2)
10	G.E.	825 (3)
10	G.E.	700
10	Al. Ch.	600/1800
10	West.	600/1200
10	G.E.	400/1600
10	West.	400/1200 (2)
9	G.E.	450/1800
8½	Diehl	900
8½	West.	850
8½	West.	350/1400
7½	Sturt.	3600
7½	Peerl's	1700
7½	West.	1450
7½	West.	1150 (2)
7½	G.E.	1150
7½	West.	975
7½	Al. Ch.	850
7½	El. Dy.	550/1650
7½	Watson	525/1150
7½	G.E.	400/1600
7½	West.	400/1600
7½	Al. Ch.	350/1050
7½	G.E.	300/1200
6	G.E.	400/1200
6	G.E.	450/1800 (2)
5½	West.	500/1500 (2)
5	West.	850
5	G.E.	900 (2)
5½	G.E.	400/1600
5	West.	1800
5	G.E.	1700
5	G.E.	1150 (2)
5	West.	1100
5	Al. Ch.	1150
5	Cont.	600/1800
5	West.	850
5	G.E.	850
5	Star	600/1200
5	El. Dy.	550/1650
5	G.E.	450/800
5	G.E.	600
5	G.E.	450/1350
5	West.	400/1200

230 VOLT DC MOTORS—Continued

5	El. Dy.	275/1100
4	G.E.	850/1150
3½	West.	850/1600
3	West.	1700
3	West.	1150 (6)
3	Roth	500/2000
3	G.E.	500/1500
2½	West.	480/1800

236 additional 230 volt D. C. Motors in stock as small as 1/20 H.P.

115 VOLT DC MOTORS

H.P.	Make	Speed
90	G.E.	900
20	West.	200/900
15	West.	1100
15	Cr. Wh.	800
10	L. Allis	3500
10	West.	850
10	El. Dy.	425/1275
7½	G.E.	850 (2)
6	Burke	650
5	Cr. Wh.	1875
5	West.	1100 (2)
5	Cr. Wh.	960

75 additional 110 volt Motors down to 1/6 H.P.

SPECIALS

10—15 H.P. 4-speed constant horsepower 600/900/1200/1800 RPM

5—15/10/7½/5 H.P. 4-speed motors 600/900/1200/ RPM

4 speed Magnetic Starters

General Electric
Westinghouse
Louis Allis.

BELTED AND MOTOR DRIVEN DC GENERATORS

200 KW G.E.	250 volts
100 KW West.	250 volts
96 KW G.E.	60 volts
80 KW El. Dy	250 volts
75 KW West.	250 volts
60 KW G.E.	600 volts
50 KW West.	125 volts
48 K West.	30 and 60 volts
45 KW West.	250 volts
40 KW Reliance	250 volts
30 KW El. Dy.	600 volts
30 KW G.E.	60 volts
40 KW Cr. Wh.	125 volts
30 KW West.	125 volts
25 KW West.	125 volts
25 KW G.E.	250 volts
20 KW G.E.	125 volts
15 KW West.	125 volts

43 additional Motor Generator Sets, 30 volts, 60 volts, 125 volts, 250 volts, and 250 volts as small as ½ K.W.

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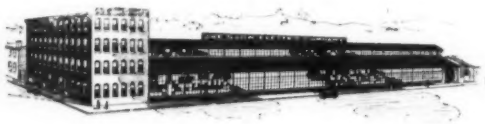

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500 KW G.E. 250 D.C. 2300/4000 A.C. 1200 RPM
500 KW G.E. 600 D.C. 2300/4000 A.C. 1200 RPM
500 KW AL-CH. 250 D.C. 2300/4000 A.C. 1200 RPM
500 KW WEST. 250 D.C. 2300/4000 A.C. 1200 RPM
300 KW G.E. 600 D.C. 2300/4000 A.C. 1200 RPM
200 KW G.E. 250 D.C. 2300/4000 A.C. 1200 RPM
150 KW WEST. 250 D.C. 2300/4000 A.C. 1200 RPM

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1—1000 KW 3 phase 60 cycle 480 volt 3600 rpm General Electric non condensing with board
1—750 KW General Electric
1—500 KW General Electric
1—300 KW General Electric
1—400 KW Moore extraction type

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1—150 HP Erie City Scotch Marine Boiler. 150 lb. pressure with stack.
1—115 HP B. & W. Sterling Boiler 150# pressure with stack.
3—Air Compressors, 9"x6", 14"x8"

Approx. 500 HP of Motors, from 5 to 100 HP, with starters, all 3 ph., 60 cy., 440 volt.

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L. J. LAND AND COMPANY

A. C. Motors & Generators

Partial List Only!

3 PHASE SQUIRREL CAGE MOTORS

H.P	Make	Speed
200	G.E.	600
150	G.E.	860
147	West.	715
100	G.E	1200
100	West.	1750
100	West.	720
100	G.E. (BTA)	375/750
75	West.	870
50	West.	1200
50	G.E.	900
50	Al. Ch.	690
40	G.E.	900
35	Wagner	850
30	U. S.	3450 Vert.
30	West.	1750 Vert.
30	Al. Ch.	514
25	Wagner	1200
25	West.	1140
25	Diehl	865 (3)
25	G.E.	900
25	Wagner	720
20	G.E.	1750 (3)
20	G.E.	1200 (2)
20	Cr. Wh.	1200 (2)
20	Al. Ch.	900 (2)
20	Diehl	900 (3)
20	G.E.	720
20	West.	1720
15	Cr. Wh.	1700
15	G.E.	1200 (3)
15	Wagner	720
15	G.E.	600
10	G.E.	720 (5)
10	G.E.	3450
10	West.	1150

325 additional three phase Motors down to ¼ H.P.

TWO PHASE SQUIRREL CAGE MOTORS

H.P.	Make	Speed
75	Cr. Wh.	870
50	Linc.	900
50	G.E.	900
40	G.E.	900
40	Al. Ch.	900
35	Al. Ch.	900
30	West.	1200
25	G.E.	1200
20	West.	1150
15	G.E.	1200
15	F & M	900
10	G.E.	1200
10	G.E.	900
7½	G.E.	900
7½	G.E. (BQS)	600/1350
5	G.E.	900
5	Al. Ch.	1200

146 additional two phase Motors down to ¼ H.P.

2 & 3 PHASE SLIP RING

H.P.	Make	Speed
250	G.E.	600
200	West.	580
200	G.E.	495
125	West.	1175
125	Burke	580
112	G.E.	900
100	F. M.	690
75	West.	1170
75	Al. Ch.	575
64	G.E.	585
60	West.	1135
60	West.	290
50	Ideal Vert.	1740
50	G.E.	870 (2)
50	West.	850
40	Wagner	1150
40	F. M.	870 (2)
40	West.	870
40	Linc.	690
30	G.E.	870
30	G.E.	690
15/35	West.	6/1200 (5)
25/55	G.E.	6/1200
20/50	West.	6/1200
25	Al. Ch.	870 (2)
25	West.	850
25	G.E.	870 (2)
25	G.E.	720
25	West.	575
20	G.E.	870
20	West.	575

116 additional Slip Ring Motors in stock down to ½ H.P.

SPECIALS

10—15 H.P. 4-speed constant horsepower 600/900/1200/1800 RPM
5—15/10/7½/5 H.P. 4-speed motors 600/900/1200/1800 RPM
4 speed Magnetic Starters
General Electric
Westinghouse
Louis Allis.

SINGLE PHASE MOTORS

H.P.	Make	Speed
20	Wagner	1160
20	Cent.	1165
7½	Cent.	3500

38 additional single phase Motors.

AC GENERATORS

150 KW G.E.	720
100 KVA West.	600
75 KVA West.	900
25 KVA West.	1800

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1—3125—KVA GE 3/60/2300V, 200#
2—1875—KVA GE 3/60/2300V, 200#
1—1000—KW, DC, West. 3/60/250; 135/200#
2—937—KVA Allis-Chal. 3/60/2300:200#
1—250—KVA GE. Non-Cond. 3/60/480

Also Any Capacity or Type Desired.

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2—4000 KVA. 60 Cy. 3 Ph. TURBOS with Surface Condensers

120 Ton Hot Ladles
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1625 KVA. 60 Cy., 250 RPM.
750 KW. 360 RPM. 60' Head.
700 KW. 257 RPM.
1500 HP. Impulse, 150 RPM.
1600 HP. 550' Head.
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1500 CFM 2 STAGE AIR COMP.

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3—500 HP. STIRLING BOILERS 200#.
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2—CENT. PUMPS 4166 GPM, 162' Head.
1—3600 GPM, 27' Head CENT. PUMPS.
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500 KW. NON-COND. 60 CY. TURBO.

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1—253 H.P., 180 Lb. Pressure

2—200 H.P. with Jones Stokers also Cochrane Feed Water Heaters from 250 HP to 4000 HP.
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2—Sprague Electric Co..Type "S" Generators. 100 kw, 125/250 volts, 400 amps, 250 rpm, #S 70593 & 70594. Connected to Ames Iron Works Engines.
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VERTICAL MOTORS

1—G.E. 50 HP 1200 RPM 3 phase 60 cycle 220 Volt
1—Reliance fan-cooled 25 HP 1750 RPM 220/440 Volt

SYNCHRONOUS MOTORS 3 phase, 60 cycle, A.C.

1—Burke 300 HP 900 RPM 440/220 Volt
1—Ideal 250 HP 600 RPM 440 Volt 3-bearing
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SLIP RING MOTORS, 3 phase, 60 cycle

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Reliance Type A, V-S Drive used six weeks 40 KW M-G set 50 HP 1750 RPM D.C. motor or 50 HP 200/600/1200 RPM D.C. motor

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ALTERNATORS SPECIAL, Allis-Chalmers, 125 KVA 277 RPM 3 Phase, 60 cycle

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1—56.9 HP Ames Economic, 125#
1—100 HP Gem City Scotch, Dry back, 150#
2—525 HP Heine, str. tube, 200#
1—300 HP Erie City, bent tube, 350#
1—214 HP Erie City, str. tube, 200#
5—150 HP HRT, stokers, 150#
1— 37 HP Vulcan Locomotive, 190#
1—46.8 HP Un. Iron Wks, Loco., 200
1— 66 HP Vulcan Iron Wks, 200#
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1—750 HP Heine, str. tube, 200#

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5—25 KVA General Elec. 220/127 Volts 3 ph. Type ATI, 80% P.F. 1200 RPM Revolving Field with Exciter.
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Direct connected to:
90 K.V.A. 3 phase, 60 cycle, 2300 volts, F. & M. Alternator #167829, Frame D401, type D, with direct conn. exciter 7½ K. W. F. & M., 257 RPM, 125 volt, continuous duty. Can be seen running on original foundation.

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SLIP RING MOTORS, 3 PH., 60-CY.

HP	Volts	Make	Speed
900	2200	G.E.	900
500	2300	Whse	514
450	2300	G.E.	600
400	2300	Whse.	1200
350	220–440	G.E.	1800
300	2200	G.E.	1800
300	2200	Whse.	514
250	2300	G.E.	600
250	440–550	G.E.	600
200	2200–550	G.E.	1800
200	2200–400	G.E.	600
150	440–220	G.E.	1800
150	440	G.E.	1800
150	550–2200	G.E.	1800
150	550	G.E.	720
125	440–220	G.E.	600
100	550–2200	G.E.	720
100	440–220	G.E.	1800
100	220–440	G.E.	720
100	220–440	G.E.	900
75	220–440	G.E.	900

SYNCHRONOUS MOTORS, 3-PH., 60-CY.

600	2200	Whse.	900
350	440–220	G.E.	900
200	2300–4000	G.E.	1200
110	440	Whse.	900
100	2200–550	Al. Chal.	1800

PUMP

1—8" Dredge Pump 1880 GPM, 120' Morris Machine Works with direct connected Slip Ring Motor 125 HP, 600 RPM, G.E.

OUTDOOR OIL CIRCUIT BREAKER

1—New 400 Amp. Type FK, 136-1328A, General Elec. 3PST, 25,000 Volt Oil Switch, Interrupting Capacity 125,000 KVA, complete CT's PT's, etc.

1—3000 ampere, type FK 25, General Electric, 3 pst, 600 volt

TRANSFORMERS—60 CYCLE

3—500 kva., G.E., type H, form KS, 13800-230/460
3—500 kva., Whse., 22000-2300.
3—350 kva., G.E., type H-KD 13200-4600.
3—333 kva., G.E., type H-KDD 2400-460/230.
3—250 kva., Whse., 13,800-460.
3—200 kva., G.E., type H 10000-600.
3—200 kva., G.E., H-KD 6600-2300/4000Y., 25 cy.
3—175 kva., G.E., 4000-480.
3—150 kva., G.E., type H-KDD 13200/2300.
3—150 kva., Al. Chal., type OISC 10400-2400.
1—100 kva., Pittsburgh, type OISC 2400-240-120.
3—100 kva., G.E., type H 2400-240-480.
3—100 kva., G.E., type H-KDD, 6900/11950Y-230/115.
3—100 kva., Whse., 22,000-2300.
2— 75 kva., G.E., type HK, 2300-230/115.
3— 50 kva., Moloney, 2300-230/115.
6— 50 kva., Whse., type SK, 13800-240/120.
3— 50 kva., Whse., 22,000-2300.

SQUIRREL CAGE MOTORS

HP	Volts	Make	Type	Speed
500	440/220	G.E.	IK	1200
550	440/220	G.E.	IK	900
400	440	G.E.	KTP	1200
400	2200	Whse.	C.S.	1800
300	2200	G.E.	IE-K	1800
250	2200	G.E.	IK	600
250	2200	Whse.	CS	1200
250	440/220	G.E.	IK	1800
200	220/440	G.E.	IK	720
150	2200	Allis. Ch.	AN	450
125	440/220	G.E.	KT	1800
100	2200	G.E.	IK	600
100	2200	G.E.	IE-K	1800
100	550	G.E.	KT	900
100	220/440	G.E.	KT	720
75	2200	G.E.	KT	900
75	2300	G.E.	IE-K	1800
60	550	G.E.	FT	3600
50	220/440	G.E.	K	1800

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75 KW, 125 V. 1200 RPM Westinghouse Conn. to 112 H.P. 2300/440 V. 3 ph. 60 cy. Ind. motor.
1—75 KW 250 V. 1800 RPM, Cr. Wh., Type CCD con. to 100 H.P., 2200 V., 3 ph., 60 cy. syn.

A.C. GENERATORS

1—500 kva., 900 r.p.m., 2209 V. Whse. Condenser.
1—300 kva., 900 r.p.m., 240/480 V., G.E.
1—225 kva., 600 r.p.m., 2200-240 V., G.E.
1—110 kva., 900 r.p.m., 440 V., G.E.
1— 60 kva., 720 r.p.m., 240/480 V., G.E.
1— 25 kva., 3600 r.p.m., 220 V., G.E.

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300 CFM Chi. Pneu. with 75 H.P. Motor
526 CFM Ingersoll-Rand, Style "JC"
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4—American Hoist & Derrick Co. double drum motor driven with 40 H.P. A.C. motors

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1—20 H.P. Northern G.E. Type 220 V D.C. 1000 RPM, complete with drum controller
1—22 H.P. G.E. Type ITC 5011, 720 RPM, 3/60/440
2—37 H.P. Otis Elevator, Type 90219, 1140 RPM, 3/60/440
4—40 H.P. G.E. Type MTC 5522, 1200 RPM, 3/60/440
1—50 H.P. Thomas Elevator, Type 1-12-35, Form M 600 RPM, 3/60/440
1—100 H.P. Northern G.E. Type, 220 V D.C., 475 RPM, complete with drum controller

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1—3000 KW GE Cond. 600 V.
1—1250 KW West Cond. 440 V.
1— 750 KW West Cond. 6600 V.
1— 600 KW GE Cond. 600 V.
1— 500 KW GE Cond. 600 V.
1— 500 KW GE Cond. 125 V. DC.
1— 400 KW West Non-Cond. 480 V.
1— 200 KW GE Cond. 2300 V.
1— 100 KW GE Cond. 600 V.
1— 75 KW GE N.C. 125 V. DC.

Turbines Only

1—210 HP Terry 250#
1—175 HP GE 110#

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1—300 HP Heine 250# Stoker
2—100 HP HRT 125#
2—150 HP HRT 150# Grates

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2—2193 CFM Direct Motor Driven
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10000 CFM 33# Turbine Driven

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2—300 GPM 65' Hd. Motor Driven
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Motor Numbers:—5283038, 5283041, 5283042, 5283044, 5283046, 5283048, 5283049, 5283050.

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3—CABLE REELS, 11 ft. diameter, 10 ft. long, with hand windlass and current collector.

This equipment was used on one dredging job, and is in very good condition. The MOTORS are suitable for STEEL MILLS, ELECTRIC DREDGES, MINING operations, etc.

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H.P.	Make	Cyl. Size	Flywheel	K.V.A
750	Corliss	32x42	20'	
600	Corliss	24x36	17'	
600	Robb-Armstrong	21x39x24		500
	Robb-Armstrong	21x36x24		360
275	Twin City	18x42	14'	220
250	McEwen	12x16	6'	200
	Robb-Armstrong	12x18x14	6'	120
	Robb-Armstrong	11x17/14	6'	100

DIESELS

Make	H.P.	R.P.M.	K.V.A.
2—Campbell	675	225	520
2—Dominion Crossley	400	514	375
1—Kromhout	350	240	250
1—Electric Boat	550	225	
1—Polar Atlas	120	275	100
1—FM CO 2	100	450	75

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K.V.A.	Head	R.P.M.
450	600 ft.	
665	500 ft.	450

STEAM TURBINES

100—5000 KW

Motor Generators or Convertors

KVA	Volts	Cycle	Phase	dc	RPM
435	4000	60	3	600	870
435	4000	60	3	600	870
180	2200	60	2	125	580
436	13200	60	3	600	720
550	13000	60	3	600	720
					375
1500	12200	25	3	275	485
1500	12000	25	3	275	485
1287	12000	25 to 60 cycle			

Synchronous Motors or Condenser

125	2200	60	3	110	245
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750	2200	60	3	100	
500	2300	60	3	20 pole 360	
5000	13200	25	3		300

120 KW 110—220 DC Turbine

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1—15 HP.—900 RPM.—Westinghouse
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2—40 HP.—720 RPM.—Westinghouse
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2—50 HP.—600 RPM.—Westinghouse
2—50 HP.—720 RPM.—Westinghouse
2—50 HP.—900 RPM.—Westinghouse
10—60 HP.—600 RPM.—Westinghouse
1—60 HP.—720 RPM.—Westinghouse
4—60 HP.—900 RPM.—Westinghouse
6—75 HP.—600 RPM.—Westinghouse
5—75 HP.—720 RPM.—Westinghouse
6—75 HP.—900 RPM.—Westinghouse
1—100 HP.—600 RPM.—General Electric
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6—100 HP.—900 RPM.—Westinghouse
2—125 HP.—600 RPM.—Westinghouse
1—125 HP.—900 RPM.—Westinghouse
2—150 HP.—600 RPM.—Westinghouse
5—150 HP.—720 RPM.—Westinghouse
2—200 HP.—600 RPM.—Westinghouse
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230 Volt D. C. Motors—2 HP to 25 HP.
550 V. Manual & Auto. Comps. 5 to 200 HP.

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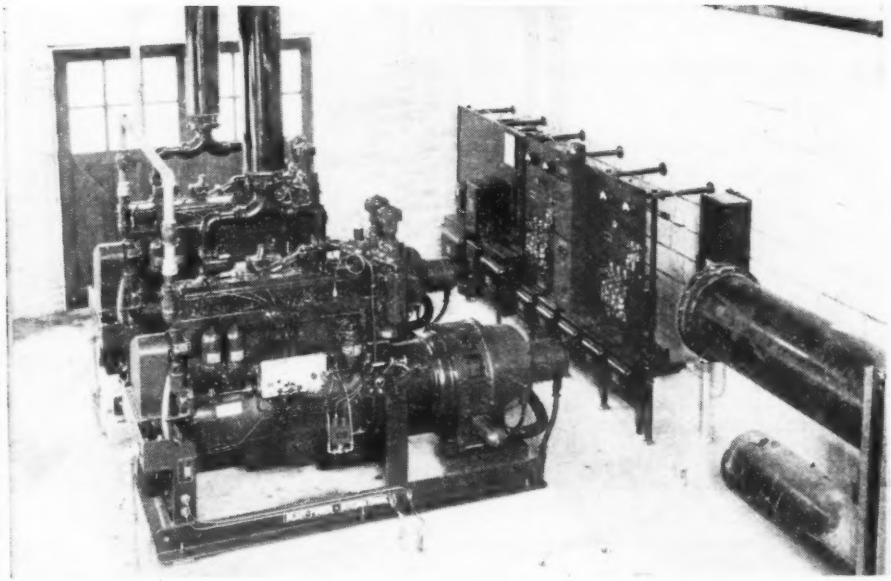

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75 KVA, 3/60/240 V. Crocker Wheeler-Russell
150 KW. 3/60/240 V. Gen. Elec.—Allis Chalmers

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60 KVA (2) 60/120 cycle, 3/60/220 V. Gen. Elec.

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10 KW. Thompson single phase, 60 cycle, 220 V.

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5000 Watt Kohler light plant
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50 HP Gen. Elec. 440 volt motor complete
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250 HP G.E. Syn. 440 volt Motor
260 HP—250 KVA, 480 volt Diesel Gen. Set
265 HP—230 KVA, 440 volt Diesel Gen. Set
360 HP—312 KVA, 2400 volt Diesel Gen. Set
200 KW Northern 250 volt DC, Bates Steam Gen. Set.
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500 KVA Westinghouse 480 volt Non-condensing Turbo Generator Set

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1 150 HP Westinghouse Motor—500 RPM —60 Cy.—3 Ph.—440 Volts, Serial No. 4595978 — Style 7.23655 — Frame 954A.

40 HP Ideal Induction Motor—Type A—Frame A306-22—Serial No. 15287 3 Ph. 60 Cy. — 440 Volts — 52 Amp. — 690 RPM — Base.

30 HP Bissell Induction Motor—Serial No. Z 26498—3 Ph.—60 Cy.—440 Volts —38 Amp., 900 RPM—Rails.

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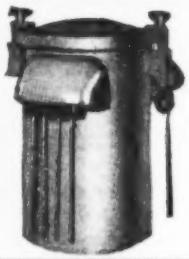

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1—100 KW Erie Ball 4 Valve Steam Generating Unit
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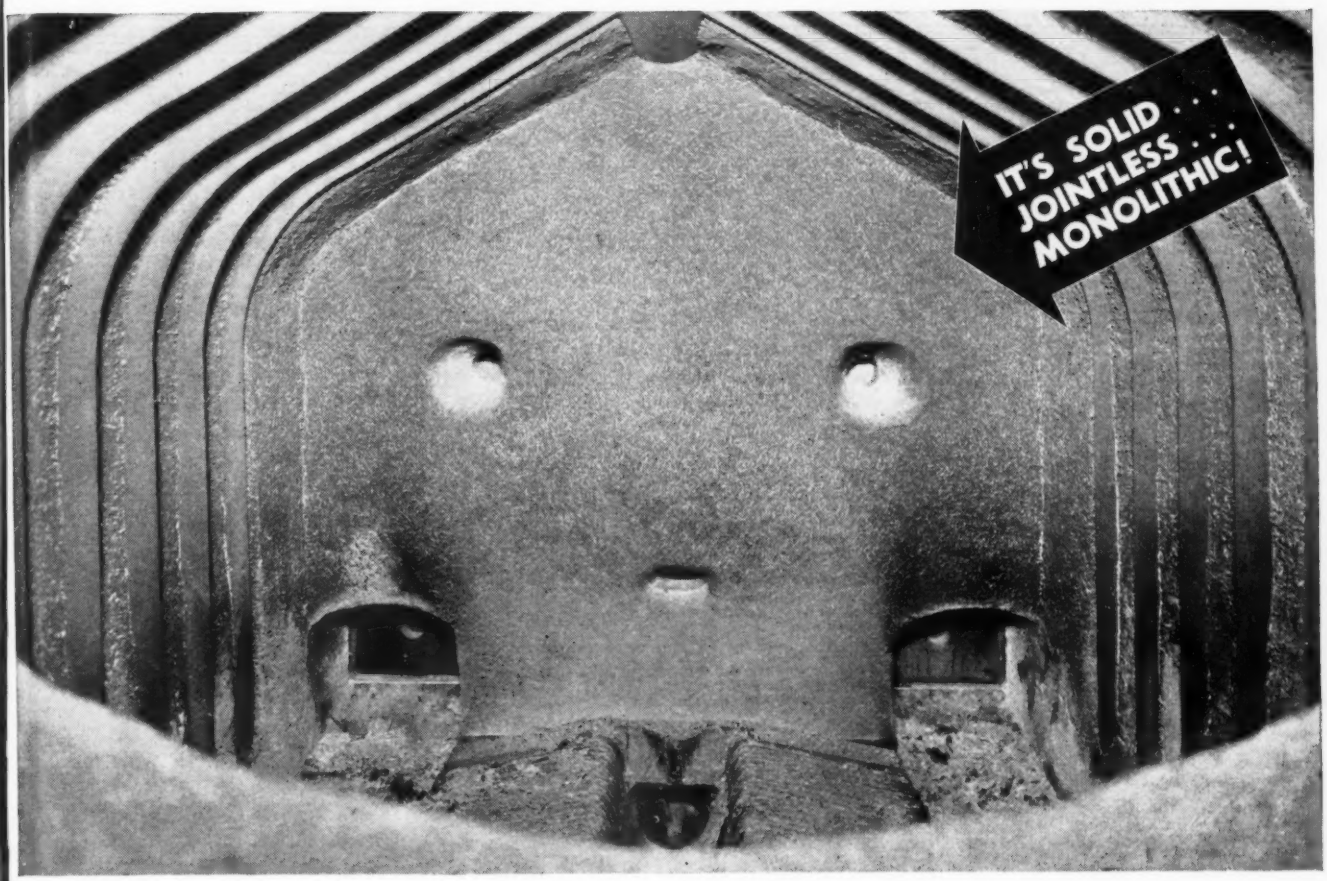

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on land or on sea for these and many more

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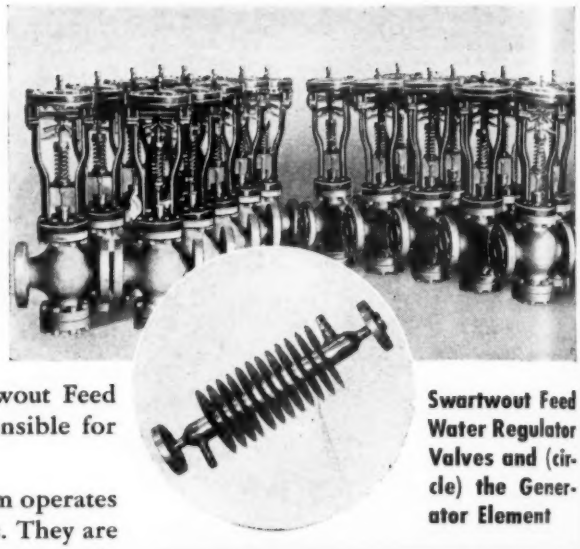

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The thermo-hydraulic principle on which the Swartwout System operates permits wide leeway in the location of the two major elements. They are connected through a single line of flexible tubing. Completely automatic regulation, requires little attention from operators, and practically no maintenance. It is easily installed, readily adjusted to varying conditions. One of the most widely used products of this 38-year-old concern. Write for Bulletin S-20-D.

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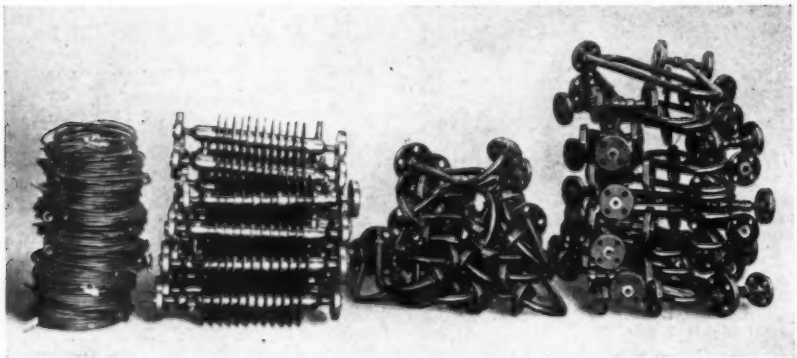
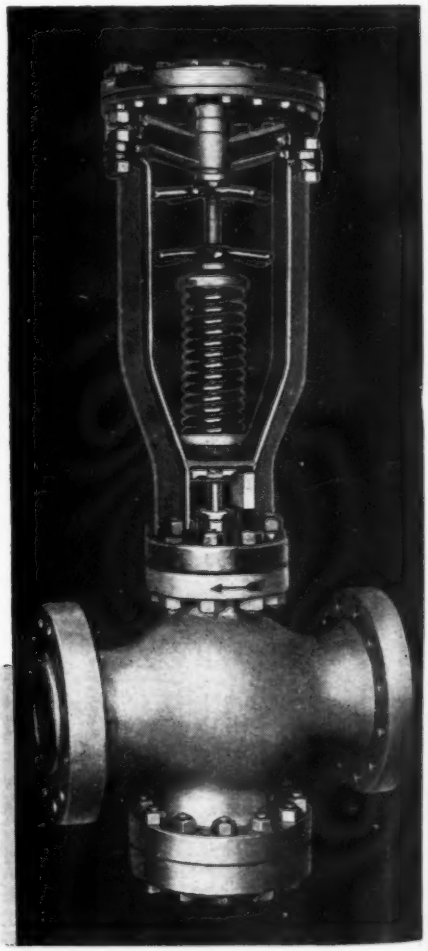


Generators, fitted piping and flexible tubing ready for shipment.



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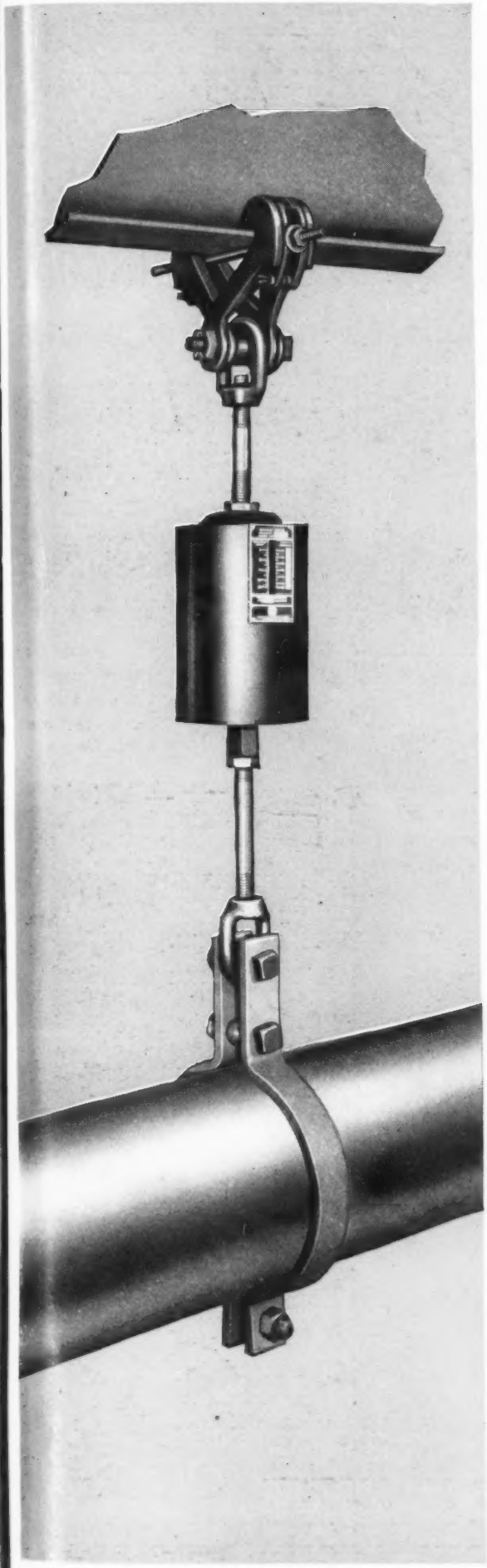

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1. Compute the load
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UNIQUE SWIVEL COUPLING PROVIDES ADJUSTMENT AND ELIMINATES TURNBUCKLE

COMPACT—REQUIRES MINIMUM HEADROOM

INSTALLATION IS SIMPLIFIED BY INTEGRAL LOAD SCALE AND TRAVEL INDICATOR

14 SIZES AVAILABLE FROM STOCK

EASY SELECTION OF PROPER SIZE FROM SIMPLE CAPACITY TABLE

14 Sizes with a Load Range from 84 lbs. to 4700 lbs.

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